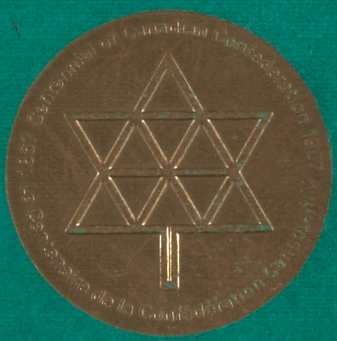

ALBERTA FARM GUIDE

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ALBERTA FARM GUIDE

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THE ALBERTA DEPARTMENT OF AGRICULTURE

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HON. HARRY E. STROM

Minister

FOREWORD

Financed jointly by the Canada and Alberta Departments of Agriculture, the Alberta Farm Guide has met with enthusiastic response.

In this edition, 30,000 copies will be provided for use of Alberta farmers and others engaged in agriculture.

The Alberta Farm Guide was published to co-ordinate and consolidate a wealth of information for the use of farmers. It provides a brief reference on a wide range of topics but is not intended to meet the needs of farmers requiring extensive information on any specific phase of agriculture.

Sources of more detailed information on farming matters are :

District Agriculturists (see page 227)

Extension Service,
Alberta Department of Agriculture,
Edmonton.

Department of Extension,
University of Alberta,
Edmonton.

Information Division,
Canada Department of Agriculture,
Ottawa, Ontario.

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NOT THE LAND ALONE

A HISTORY OF AGRICULTURE IN ALBERTA

By E. B. Swindlehurst

Among the many who had to do with the growth of agriculture in Alberta were the policy makers, the administrators, the educators, the people on the land, and the researchers. These were not hard and fast lines. Some of the policy makers were farmers and educators, some of the farmers were educators and policy makers, and more than one educator proved himself a sound administrator.

Among policy makers at the turn of the century was the Minister of the Interior in the government of Sir Wilfred Laurier. He was Sir Clifford Sifton.

In 1883, under the administration of Sir John A. Macdonald, the Canadian Pacific Railway had reached Calgary. It spanned the continent from coast to coast in 1885. Only 15 years before, in 1870, Rupert's Land (the present prairie provinces) had been turned over to Canada by Great Britain.

In 1871, provision was made for homestead entries on quarter sections with a fee of $10.00 and residence requirements of five years. This was changed in 1882 to a three-year residence.

It was in the middle 1870's, with the decrease of the buffalo, that ranchers from Montana and elsewhere began to drive their cattle onto the lush grass of the Canadian prairies. These ranchers squatted on the land and settled around the water holes. But the government soon officially granted them large areas for grazing lease, to be terminated as homesteaders needed the land.

And those homesteaders were not long coming, but not quite fast enough to suit some of the policy makers. Sir Clifford Sifton had an idea. Bring in people who are used to the land, he urged; people who are born and bred on the land and to whom land ownership is one of the greatest favors you can offer. Sir Wilfred was in full sympathy with this idea, and encouragement of immigration from the Ukraine resulted in an influx of its sturdy people onto the lands of the prairie. They cleared and plowed and sowed, and made thriving farms out of this raw, new country.

But others were coming. In 1921, of the 600,000 people in Alberta, 24,000 were Ukrainian, 31,000 French, 35,000 German, 44,000 Scandinavian, and 351,000 British.

On September 1, 1905, Alberta became a province. The urge was still to inform people that few places offered greater promise than the new province of Alberta. A provincial publicity bureau was set up with offices in Montreal, Toronto and Winnipeg, where immigrants were informed of the potential of the province and induced to settle here.

The annual report of the Alberta Department of Agriculture for 1911 mentions that 2,500 settlers came to Alberta that year in the months of April and May. "This great influx of settlers blocked the hotel accommodation at both Calgary and Edmonton to such an extent that the daily press on April 10 stated 'that not a hotel in the city could furnish accommodation and the situation threatens to become serious, and there is not a vacant building in the city in which to quarter immigrants. Not a room, nor a dwelling, not a shack of any nature is vacant, and the crowds of newcomers will face the necessity of sleeping with only the stars for a canopy, if the city authorities do not provide accommodation of some nature'." Calgary's population in 1911 was 43,704 and Edmonton's 24,900.

But by that time, the policy makers of Alberta were concerned not only with persuading people to come to Alberta, but with doing something for those already here.

Shortly after Alberta became a province in 1905, there came into the provincial cabinet, a man whose initiative and energy would seem to have parallelled that of Sir Clifford Sifton in the federal cabinet. Duncan Marshall followed the Honourable W. T. Finlay as Alberta Minister of Agriculture in 1909, and he started in immediately to give his full energy to agriculture in the province. Duncan Marshall was one of the best speakers Alberta has ever known. "He could talk a bear down out of a tree," remarked one of his early acquaintances, A. W. Murphy of Medicine Hat.

Farm people and the land were Marshall's prime interests. Here was a new land, to which were coming people of many countries and many occupations. Many of them had little or no farming experience, and most of those who had farmed before had done so under vastly different conditions. What was needed, Marshall decided, was demonstration farms. Not one big, central farm, but several farms conveniently located. This would serve two purposes: It would reduce the distance the farmers would have to travel to observe the best farming practices for their areas, and it would offer a chance to locate the farms under the varying soil and moisture conditions of the province.

So seven of these farms were established — all the way from Medicine Hat and Claresholm in the south, to Athabasca in the north. Crops were grown, varieties introduced, and cattle handled under conditions that would exist on the ordinary good farm. There was to be no coddling of livestock, although care and management were stressed. One purpose of these farms was to show the local people what could be grown in Alberta. Field days were held there periodically, and the farmers with their wives and families were encouraged to attend.

But there was another idea in Duncan Marshall's mind; and that was the training of farm young people for an interesting and successful life on the farm. By 1913, schools of agriculture had been completed on three of the demonstration farms mentioned. These were at Vermilion, Olds and Claresholm. Schools were also erected later at Gleichen, Youngstown and Raymond. They had their ups and downs but two of them (at Olds and Vermilion) remain to this day, together with a more recent one at Fairview in the Peace River region. Their scope has now been widened, and their name changed to Agricultural and Vocational Colleges, but they still serve the interests of farm boys and girls and of the many industries now associated with the widened field of agriculture in this country. "Important though agriculture is," said Duncan Marshall in 1914, "it is of greater importance that opportunities for improvement and enjoyment in life should be given to these young men and women through these schools."

On this topic of education another name should be mentioned, that of Henry Marshall Tory. Here was a man who was educator, policy maker, administrator and researcher. Dr. Tory was chairman of the Board of Agricultural Education set up by Duncan Marshall to guide the affairs of the schools of agriculture. But more than that, he was the first president of the University of Alberta and the man who turned 258 acres of riverside bushland into our present institute of higher learning. That founding of the University of Alberta at Edmonton is an epic in itself and is excellently told in E. A. Corbett's "Henry Marshall Tory".

Dr. Tory had an abounding interest in the people of the province. Alberta's university was to be no ivory tower. While high academic standards would be required of the students, the university had another need to satisfy — to get out among the people. "The people demand that knowledge shall not be the concern of scholars alone," he said in his first convocation address. "The uplifting of the whole people shall be its final goal."

So from the beginning, that first staff, consisting of the president and four others, was in constant demand for speaking engagements throughout the province. It was not only farmers they addressed, but boards of trade, clubs, and a variety of social organizations as well.

In 1912, Dr. Tory felt that the time had come for appointment of a full-time director of extension. He appointed A. E. Ottewell, a graduate of that first class at the University of Alberta, and the son of a pioneer family at Clover Bar. Out into the country the new director travelled, carrying films, slides and books, and lecturing in the towns and country schools along the way. From the beginning, A. E. Ottewell became a well-known and welcome figure wherever he went.

But culture was a sideline with the people of the prairies. Agriculture was their business. Those were times of great enthusiasm, and in spite of the hardships of homesteading, there was a confidence that carried through. But as the years went by, that confidence was to be sorely tried. It wasn't enough to break the land and sow the seed. It sometimes seemed that everything combined to try the patience and the courage of the farmer.

Since the great plague of grasshoppers in the Selkirk Settlement of Manitoba in 1818, these insects returned again and again to take their toll of the crops. Other destructive insects of those early days were the pale western cutworm and the wheat stem sawfly of the plains. The fungus disease of rust hit the crops

from time to time. Frost caused damage. Weeds crept in. Drought and tillage took the fibre from the fields, and the winds drifted the soil in clouds over the countryside. It seeped into the houses and into the food, and little, it seemed, could be done about it.

But over the years, help was at hand. Development of Marquis wheat by Dr. Charles E. Saunders at the Dominion Experimental Farm in Ottawa, and its introduction to farmers of the west in 1909, meant earlier ripening and reduction of the frost hazard. Still earlier wheats have since been developed, but none of better quality.

By this time, the Dominion experimental farms were no longer confined to eastern Canada and the older prairie province of Manitoba. It had already been recognized that the soils, climate and production methods of the newer provinces of the west demanded study.

The first of these experimental farms in Alberta was started at Lethbridge in 1906. Settlers were coming in rapidly, and not only irrigation farming but dryland grain growing was expanding. With his knowledge and experience of irrigated farm practice in the north-western United States, Dr. W. H. Fairfield proved an excellent choice for superintendent. He retired on superannuation in 1946, after seeing tremendous growth and many changes during his 40 years in charge of the farm.

In the early years of the Lethbridge Experimental Farm, topics of interest included use of irrigation water, methods of breaking land, kinds of crops that could be grown, suitable varieties and rotations, and rates and dates of seeding. Since this was an early ranching area, studies on cattle and sheep were not neglected. The relationship between range production of livestock and production of feed in the irrigated areas was early recognized and experiments initiated on winter finishing of cattle and lambs. Later studies and the expansion of irrigation were to result in a flourishing sugar beet industry. The value of the farm and its staff was again demonstrated when the drastic drought and soil drifting of the early 1930's began.

In 1907, the Lacombe Experimental Station was founded. This was in the parkland area on the rich black soils of the province. But staff responsibilities did not rest there. Their area under study extended from Calgary north to Lesser Slave Lake and from the Saskatchewan border to the Rockies — an area embodying all the major soil types of the province.

The first work of the experimental farm at Lacombe was of a demonstrational nature, but as more knowledge became available thoughts turned to development of a sound, balanced type of farming. Crop rotations were started, livestock feeding, breeding and management was undertaken, and studies were initiated in the improvement of cereal and forage crop varieties. The farm was later brought into prominence by the work on swine genetics of present Superintendent J. G. Stothart and Dr. Howard Fredeen that resulted in production of the Lacombe breed.

With the Canadian Pacific Railway line in operation between Edmonton and Calgary before the turn of the century, the settlers were moving in. Among the first to arrive at Lacombe were the parents and family of Dr. P. R. Talbot, who was for many years provincial veterinarian for the Province of Alberta. He tells in the Alberta Historical Review (Volume 3, Number 3) of the family coming to Lacombe in 1892. He speaks of their early farm experiences, of the settlers in their covered wagons passing by on the Calgary Trail, of friendly relationships with the Indians, and of how Father Lacombe visited the Talbots in 1893 and 1894.

Log and sod shacks were often the first dwellings on the prairies and parklands of Alberta. But as the country opened and building logs became more difficult to find, frame dwellings dotted the landscape. Luxuries there were none, but the people were young and if food and shelter were available they were content to look forward to better times in the future. It was the women particularly who felt the loneliness and lack of facilities — no doctors, no phones, and the only transportation, the team and wagon. Buggies and democrats came later and then the luxurious early touring cars.

In the fields, the plow, disc, harrows and seed-drill were the implements of spring; the harrow cart was a luxury, even though it meant sitting in the dust all day. Then too, the harrow cart required another horse for power — and horses

were expensive. Haying was limited to use of the mower and rake, with the home-made rack to haul the sun-cured prairie wool from the field. On the broad expanse of the range, the sweep was used to stack the hay against winter needs. At harvest, the prevalence of "binder and knotter troubles" induced Professor J. Macgregor Smith, of the Department of Agricultural Engineering, to produce in 1925 his well-known University of Alberta bulletin of that name.

Harvesting was the settler's delight, and although a good crop meant heavy stooking, it also meant full bins and at least a semblance of returns for his labor. Then threshing came along. In some areas, there were owners of grain separators who made a practice of custom threshing among their neighbours. For teamsters, they relied on those same neighbours. So we find a small threshing crew of eight or so teams, together with the engineer and separator man, moving around from farm to farm.

A caboose was dragged around for sleeping quarters, but meals were provided by the farmer whose grain was being threshed. This meant an extremely busy time for the wives and daughters of those farmers. They vied with each other as to how well they could feed the threshers, and the men of the threshing crew lived like kings for the brief period of their threshing engagement.

Breaking and threshing were long the chief uses of the tractor. The old sod-busting steamers were used early on the open prairie, and these were followed by the large, rugged, steel-wheeled gas tractors. It was much later that the smaller, more manoeuverable, riding-on-rubber type tractor replaced the horse for general farm work.

In the meantime, the elements were causing concern. Trouble had arisen that meant a radical change in soil tillage methods. In some years of the 1920's and in the early 1930's, severe drought had struck the southern prairies. Rainfall at the best is light in these areas, and when year after year the rain held off, the soil drifted in clouds that hung in the air and blotted out the sun. It seeped around doors and windows until a fine layer of dust lay everywhere.

A. E. Palmer and other staff members of the experimental farm at Lethbridge went around preaching the gospel of soil conservation. "It's the beginning that counts," they said. "When soil drifting starts it creeps, but with gathered strength the black clouds drive with force across the land." So methods were devised of holding or slowing up the soil before it could do harm. Straw was spread on the hilltops, since these were the areas most subject to erosion, and strip farming came into general use. This strip farming was a modification of the practice of summerfallow that had been a tradition on the western prairies. The purpose of the summerfallow was to conserve moisture and control weeds, but a well-worked, bare field was open to the full force of the howling wind.

As far back as 1919, there had been those who had become alive to the soil drifting danger. How strip farming started was told in 1946 by Chris. T. Withage, operator of the Canada Department of Agriculture Illustration Station at Nobleford. In a letter to R. M. Putnam, later deputy minister for the Alberta Department of Agriculture, Mr. Withage reported that this practice originated in the Monarch district, northwest of Lethbridge. He was one of the first farmers to employ strip cropping practices.

He relates how, in 1919, he was bringing home a cow from Granum. The whole countryside was drifting, and he noticed as he travelled eastward along the road that there was no blowing on summerfallow lying just to the east of fields that had been in crop. "If there were more west sides to our summerfallow fields," he told himself, "we wouldn't have this soil drifting." So he conceived the idea of running strips up and down the field across the direction of the prevailing wind, so that there would be more west sides to the fields.

The practice of strip cropping was so successful that it was adopted as general farming practice all over those sections of Alberta where soil drifting was a menace. The strips varied from 10 to 50 rods in width, the average being about 25 rods. The strips usually ran north and south, although in some districts because of local conditions they ran east and west.

With the soil drifting badly over wide areas, it was soon realized that there was something wrong with the type of cultivation practiced. The idea of "plow deep while sluggards sleep" was not conducive to good farming on these open prairie lands. So implements were devised that, instead of burying the trash, left it on or near the surface to check the force of the wind.

In the spring of 1932, Professor J. Macgregor Smith in a radio talk over CKUA in Edmonton, spoke of the advantages of the one-way disc in the control of soil drifting, and in 1935, C. S. Noble of Nobleford introduced his first blade cultivator, which left the stubble on the surface and still further reduced the soil drifting hazard. It was in that year too, that the "Prairie Farm Rehabilitation Act" was introduced in the Federal House of Commons. In an address delivered to the Eastern Ontario and Central Ontario Locals of the Canadian Society of Technical Agriculturists in January, 1938, Dr. E. S. Archibald, director of the Experimental Farms Service at Ottawa, spoke of the prairie situation since 1929. In the course of this address he remarked :

> "Succeeding years of disastrous drought, grasshopper damage, soil drifting, and necessary large scale relief to farmers in central and southern Saskatchewan, southwestern Manitoba, and southern Alberta, covering a period of five years, inclusive of 1934, convinced the Dominion Government that drastic and large scale rehabilitation measures were necessary if the enormous earning power of Western Canada due to a population of most capable farmers in their particular type of production was to be retained."

"The regrassing of blown-out and abandoned areas," said Lethbridge Superintendent A. E. Palmer, "became a major undertaking as a result of prolonged drought coupled with lack of information on proper land use."

In those years too, general economic conditions added to the troubles of all. Only those who experienced the depression of the 'thirties can fully appreciate the distress and frustration of that time.

Towards the end of the First World War, another part of the province was coming into prominence. Settlers were pushing north. In 1911, the Dominion Department of the Interior reported 2,000 souls in the Peace River district, "including settlers, traders, missionaries and Indians". In 1921, there were nearly 20,000; and with extension of railways into the area a steady stream of settlers followed.

One of the early settlers was W. D. Albright, later to become superintendent of the area experimental farm. He arrived by democrat with his family, and chose a homestead site near Beaverlodge. He was a graduate of the Ontario Agricultural Collge and enthusiastic about farming prospects in the Peace. Interested in finding the best varieties for this area, he sowed in 1914 plots of grain supplied by the director of Experimental Farms at Ottawa. In 1917, the Albright farm was created an experimental substation, and in 1919 Mr. Albright became superintendent. His experimental work, his writings, and his missionary zeal in the cause of agriculture, throughout the Peace River region and beyond, are remembered in the form of a cairn unveiled by his successor, Superintendent E. C. Stacey, at the Beaverlodge Experimental Station in 1954.

Many changes have occurred since the formation of the province in 1905. Good crops and poor crops; hail, drought, frost, grasshoppers, and depression; wheat surpluses and wheat shortages; conditions of war and conditions of peace—all are part of the history of agriculture in this Province of Alberta. Strides have been made in many directions, of which organization among the farmers, for better conditions in their vocation, are not the least. The farm organizations in this Province of Alberta stand as a lasting tribute to those who have gone before, and they have lightened the load of those who came after.

No less remarkable has been the work of the scientists and administrators in the cause of farm and home. Work of the research staffs of the Canada Department of Agriculture, the faculties of Agriculture and Home Economics of the University of Alberta, the policy administrators and extension workers of the Alberta Department of Agriculture, has resulted in savings of time, effort and nervous energy on the part of farmer and homemaker alike. Chemical control of weeds and insects; dairy technology; studies of soil chemistry and physics; increased knowledge in livestock feeding, breeding and management; farm machinery innovations; and conveniences in the home and its surroundings, are just some of the benefits.

Not to one alone goes the glory. It is to the pulling together of policy makers, administrators, farmers, educators and researchers that we owe the prestige of agriculture in Alberta today.

CLIMATE OF ALBERTA

The climate of Alberta is mainly Continental. A Continental climate has greater extremes and variability than a Maritime climate. Most of the air circulating over the province comes either over the mountains from the west or from the north and northwest by way of the Mackenzie River Basin. Alberta is located too far west to receive much of the warm moist air from the Mississippi Basin. This air frequently penetrates northward into Saskatchewan and Manitoba.

The mountains modify the climate. Air from the west may bring a chinook. The cold air from the north is steered eastward by the mountains so that moderation of the cold air takes place in Alberta before it occurs to the east.

At the same latitude, the western parts of the prairies are warmer in winter than the eastern parts. In winter, the temperature gradient from south to north is considerable. In the summer, it is very slight. For this reason, summer temperatures do not limit crop production in the northern areas as much as might be expected.

Much rain and snow fall usually is caused by warm Pacific air crossing the mountains and coming together with the drier, cooler air over Alberta. Prolonged precipitation occurs with surface winds from the east. Aloft, the Pacific air rising over this lower layer becomes chilled and its moisture falls out as rain or snow. Some of the more extensive rains in the south may occasionally be due to a similar association of warm, moist air from the Mississippi Basin and cold Polar air. Much of the useful summer rainfall comes in the form of heavy showers, occurring when the air is unstable. Air can become critically unstable by heating from below as it passes over hot ground or by cooling aloft.

CLIMATE VARIATION

Agriculture in Alberta is carried on under very close to marginal climatic conditions. While average weather conditions are favourable, extreme changes are so frequent that the production of some crops becomes a very risky undertaking.

Rainfall variability is greatest in the prairie region, somewhat less in the parklands and least in forested areas.

Late spring and early fall frosts increase the risks of agriculture in the northern and western areas. Fortunately, the drought hazard is less in these areas. Spring frosts do not limit agriculture to the extent that early fall frosts do. When ripening is delayed, fall frosts can be disastrous. Early seedings, and the use of phosphatic fertilizers, hasten maturity, reducing the risk of frost damage.

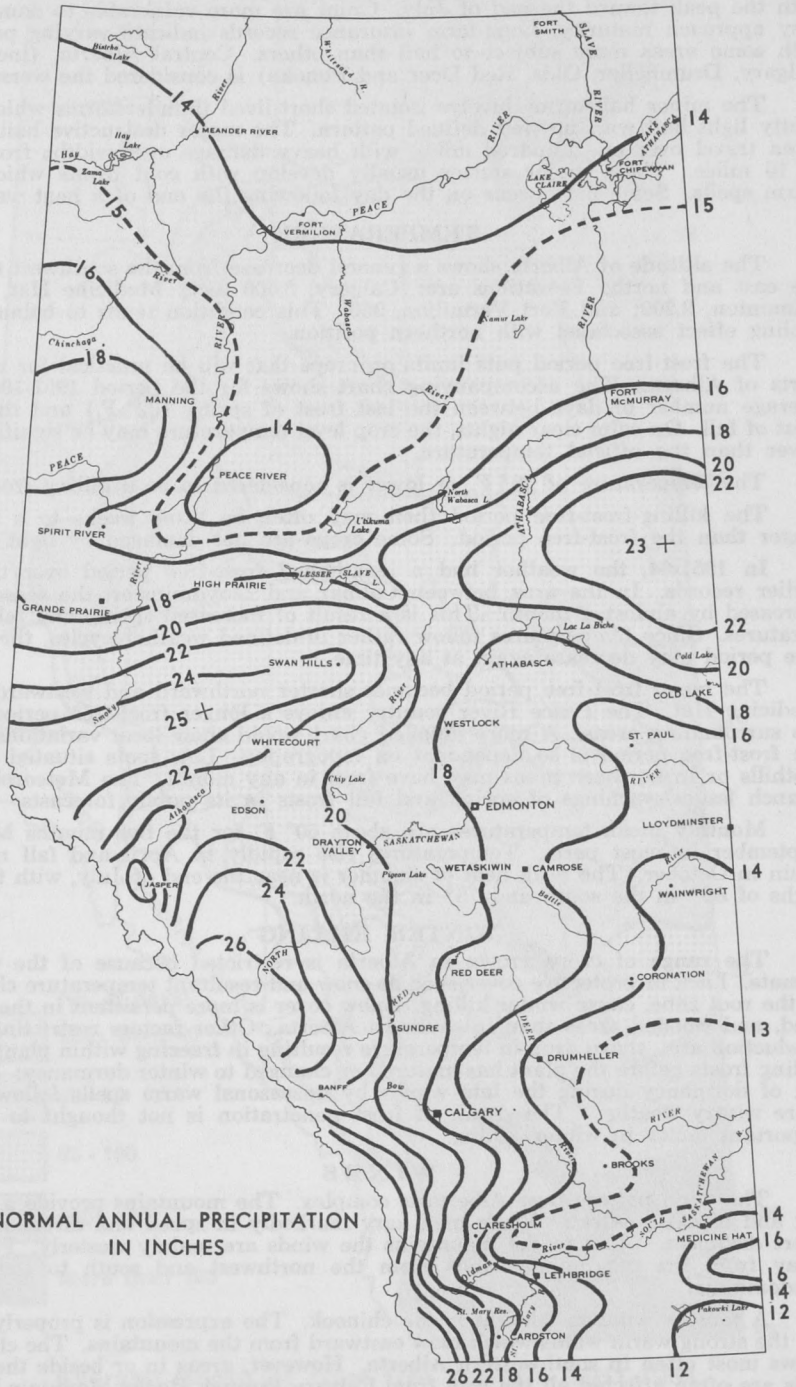
PRECIPITATION

Alberta is in the rain shadow of the Rocky Mountains and is therefore relatively dry. However an included map shows that there are marked variations in the average annual precipitation over the province. Precipitation is greatest along the foothills, diminishing rather rapidly toward the east and toward the north. There is a band of fairly heavy precipitation in a southwest to northeast line from south of the Peace River region across the Swan Hills to the Pelican Mountains and eastward. This heavy precipitation is associated with higher ground, most of which is heavily forested. Precipitation varies rapidly near the Rockies, hence values are omitted for this area on the map.

Water loss by evaporation from the soil plus that consumed or transpired by crops is termed "evapotranspiration". This varies from one region to another. High rates are caused by wind, sunshine and high temperatures. The value of snowfall in the production of crops varies throughout the province from year to year. In general, snowfall constitutes only about 25 per cent of the total annual precipitation. Chinooks melt the snow and the moisture is evaporated in southern Alberta. Heavy run-off wastes much of the snow moisture in the Peace River and other northern regions.

HAIL STORMS

Summer hail is associated with thunderstorms. All thunderstorms do not produce significant hail. However, in Alberta, apparently about one in five thunderstorms is accompanied by hail. Hail becomes more frequent and destruc-


NORMAL ANNUAL PRECIPITATION
IN INCHES
26 22 18 16 14 12
FORT SMITH
MEANDER RIVER
FORT VERMILION
PEACE RIVER
MANNING
SPIRIT RIVER
GRANDE PRAIRIE
HIGH PRAIRIE
SWAN HILLS
WHITECOURT
EDSON
JASPER
DRAYTON VALLEY
EDMONTON
WESTLOCK
ATHABASCA
FORT McMURRAY
COLD LAKE
ST. PAUL
LLOYDMINSTER
WAINWRIGHT
WETASKIWIN
CAMROSE
RED DEER
CORONATION
SUNDRE
DRUMHELLER
CALGARY
BANFF
BROOKS
MEDICINE HAT
CLARESHOLM
LETHBRIDGE
CARDSTON

tive as the summer advances. The hail season is mainly mid-June to late August with the peak toward the end of July. Crops are more vulnerable to damage as they approach maturity. Long-term insurance records indicate varying patterns with some areas more subject to hail than others. Central Alberta, (including Calgary, Drumheller, Olds, Red Deer and Ponoka) is considered the worst area.

The minor hailstorms involve isolated short-lived thunderstorms which give spotty light hail with no well defined pattern. The major destructive hailstorms often travel over one hundred miles, with heavy damage over widths from five to 10 miles. These major storms usually develop with cold fronts which end warm spells. Some may occur on the day following the end of a heat wave.

TEMPERATURE

The altitude of Alberta shows a general decrease from the southwest toward the east and north. Elevations are: Calgary, 3,400 feet; Medicine Hat, 2,400; Edmonton, 2,200; and Fort Vermilion, 950. This condition tends to balance the cooling effect associated with northern position.

The frost-free period puts limits on crops that will be practical for various parts of Alberta. The accompanying chart shows for the period 1951-1964 the average number of days between the last frost of spring (32° F.) and the first frost of fall. On calm clear nights, the crop level temperature may be significantly lower than the official temperature.

The temperature of 28° F. or lower is considered to be a killing frost.

The killing-frost-free period then may often be three weeks to a month longer than the frost-free period. Some crops are not damaged by light frosts.

In 1951-64, the weather had a lengthened frost-free period over that in earlier records. In the area between Calmar and Lloydminster, the season has increased by almost a month. This is a result of increased spring and fall temperatures. Since temperatures follow rather ill-defined weather cycles, the frost-free period may decrease again at any time.

The mean frost-free period becomes shorter northward and westward from Medicine Hat. The Peace River country enjoys a longer frost-free period than the surrounding areas. A more detailed chart would show local variations since the frost-free period is so dependent on topography. Low spots situated in the foothills or in northern areas may have frost in any month. The Meteorological Branch issues warnings of spring and fall frosts in its public forecasts.

Monthly mean temperatures are above 50° F. for the five months May to September in most parts. Temperatures rise rapidly in April and fall rapidly again in October. The peak heat of summer is near the end of July, with typical highs of 85° in the south and 75° in the north.

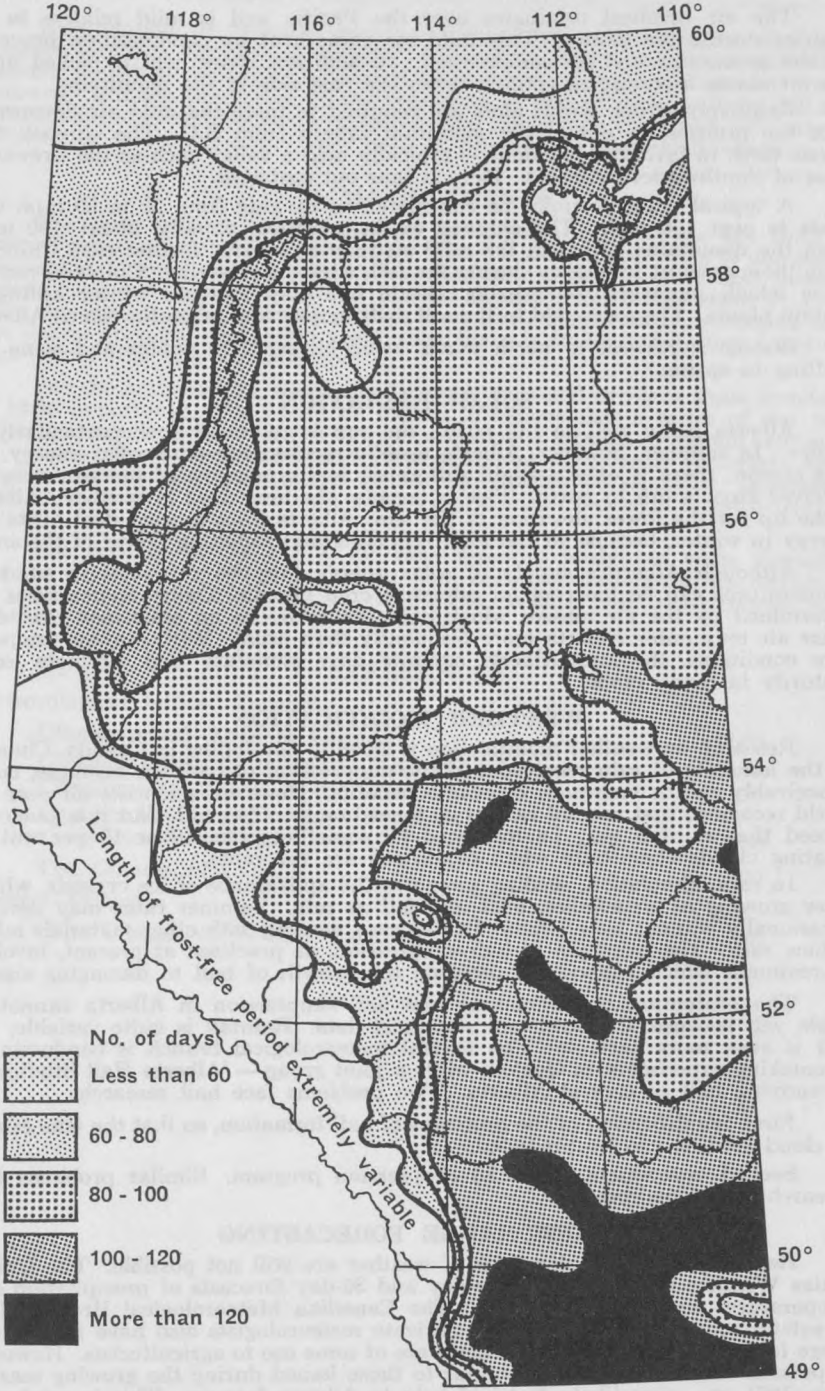
WINTER KILLING

The range of crops grown in Alberta is restricted because of the winter climate. Lack of protective cover such as snow and resultant temperature changes in the root zone, cause winter killing. Snow cover is more persistent in the parkland, and wooded areas than in southern Alberta. Other factors restricting crop production are: sharp drop in temperature resulting in freezing within plant cells; killing frosts before the plant has matured or changed to winter dormancy; breaking of dormancy during the late winter by unseasonal warm spells followed by more wintry weather. The depth of frost penetration is not thought to be an important factor in winter killing.

WINDS

The wind pattern over Alberta is complex. The mountains provide a steering and blocking effect. Winds may vary markedly in speed and direction over short distances. Close to the mountains the winds are mainly westerly. Farther away from the mountains, winds from the northwest and south to southeast predominate.

A famous wind in Alberta is the chinook. The expression is properly used for the strong warm winds which blow eastward from the mountains. The chinook blows most often in southwestern Alberta. However, areas in or beside the foothills are often affected all the way from Calgary through Rocky Mountain House to Edson and the Peace River country.



Average length of frost-free period – 1951-1964.
(Map by Prof. R. W. Longley, University of Alberta)

The air involved originates over the Pacific and is mild relative to the prairies during the winter. This mild air gains heat by condensation processes on the mountains and by compression. In addition, more heat is picked up as the air starts to compress coming down the east side of the mountains.

Relatively strong winds aloft are required to force the mild air downwards over the prairies, or out of the mountain valleys from B.C. The chinook then bursts forth in favourite locations — typically near a valley such as the Crowsnest Pass of Southwestern Alberta. Here it fans out eastward.

A typical chinook might be considered as ranging from 25 to 50 mph with gusts to over 100 mph. The chinook weakens rather rapidly about 100 miles from the mountains, although the mild air may be carried farther east. Chinooks have their greatest frequency during the fall, winter and spring. Chinooks remove snow which increases the grazing season but may increase winter killing of certain plants. They also add to the soil drifting problem in southwestern Alberta.

Strong, northwest to north winds bring blizzards in winter and some soil drifting in spring.

SOLAR RADIATION

Alberta being well to the north, the sun is relatively low, particularly in winter. In summer, however, Alberta usually receives adequate solar energy. At this season, there is only a slight difference in the amount of the sun's energy received from south to north. This is because the long days in northern Alberta make up for the lower elevation of the sun. Alberta loses a great deal of its sun energy in winter, because of the high reflecting and radiating power of the snow.

Although Alberta's supply of solar energy may be sufficient in summer, temperatures can be too cool for adequate crop growth. Daily temperatures are determined by the air masses which enter an area. In an abnormal year, cold polar air may enter Alberta more frequently than usual. With average temperature conditions, the long Alberta summer days stimulate and promote early maturity in many crops.

WEATHER MODIFICATION

Research on weather modification is steadily developing in Canada. Changes in the amounts of rain received and the suppression of hail, for example, could conceivably return enormous economic benefits. However, scientists all over the world recognize that rainfall cannot be turned on or off at will. But it is generally agreed that rainfall may be increased by something like 10 or 15 per cent by treating clouds chemically when conditions are favorable.

In rain stimulation, seeding promotes the appearance of ice crystals, which, after growing as snowflakes, melt and fall as rain. Summer rains may develop occasionally without ice crystals. In this case, seeding with other materials might induce rain. The principle of hail suppression, as practised at present, involves a treatment which supposedly prevents the growth of hail to damaging size.

The evaluation of rainmaking and hail suppression in Alberta cannot be made yet, because of insufficient statistical data. Rainfall is quite variable, but hail is even more variable. The federal meteorological branch is conducting a rainmaking experiment in Quebec, while a joint group — 'Alberta Hail Studies' — is studying hail in central Alberta. Two problems face hail research:

First, identification of the processes of hail formation, so that the true effects of cloud seeding can be predicted.

Second, assessment of a hail suppression program. Similar problems face research in rainmaking.

LONG RANGE FORECASTING

Reliable long range forecasts of weather are still not possible. The United States Weather Bureau issues five-day and 30-day forecasts of precipitation and temperatures compared to normal. The Canadian Meteorological Branch plans to extend into this field gradually. Private meteorologists also have issued long range forecasts. Forecasts for a month are of some use to agriculturists. However, at present three-day forecasts similar to those issued during the growing seasons since 1961 are more likely to be of help to Alberta farmers. This is conducted jointly by the meteorological branch (federal department of transport) and the provincial department of agriculture.

Examination of climatic data for Alberta gives little encouragement to attempt forecasts for several months. At present, there can be no outlook for summer issued in the spring. There is some tendency for persistence in weather patterns. But the prediction of the beginning or end of such spells is still most difficult. Some breakthrough in meteorological knowledge, combined with machine methods to sort data, is the only hope at present for seasonal forecasts.

CLIMATIC TRENDS

The most reliable information on the departure of the ice age from our prairies sets the time at 9,000 years ago. The ice melted, according to one theory, because of a trend toward warmer weather over a period of several thousand years. Geologists have estimated a rise in mean annual temperature of 10° F. since the last ice age. This change may have come about slowly, averaging about one degree increase each 1,000 years. But there is evidenc that abrupt warming took place after the ice retreated.

For the agriculturist, whose brief span is reckoned in years, these trends are of little importance. We would be foolish to believe that a series of wet years indicate a trend, or that a series of violent storms is a result of atomic explosions. In regions where the normal climate is marginal for growth of certain crops, farmers must simply be prepared for adverse weather occasionally. In northern regions, the risk is high and even a moderate climatic recession might cause crop failure.

The drought in the 1930's, the long series of fairly wet years thereafter, and the dry spell of 1960-61 broken in 1962, are only examples of the variability in weather patterns. No one can yet predict weather for years ahead since detailed studies fail to reveal reliable cycles.

REFERENCES

Meteorological Office, Toronto :

Climatological Atlas of Canada	——	$1.00
Climatic Data Sheets #9-64 (temperatures)	——	.10
Climatic Data Sheets #5-65 (precipitation)	——	.10
Climatic Maps for the Prairie Provinces for Agriculture, Department of Transport	——	1.50
The Climate of Canada	——	1.00

Queen's Printer :

"The Climate of Central Canada"	——	1.30

SOILS AND FERTILITY

The soils of Alberta have been placed into six broad groupings. The southeast portion of the province is relatively dry. Moisture efficiency increases and the climate becomes progressively more humid towards the west and north. This has had a dominant effect on the native vegetation and the character of the soil.

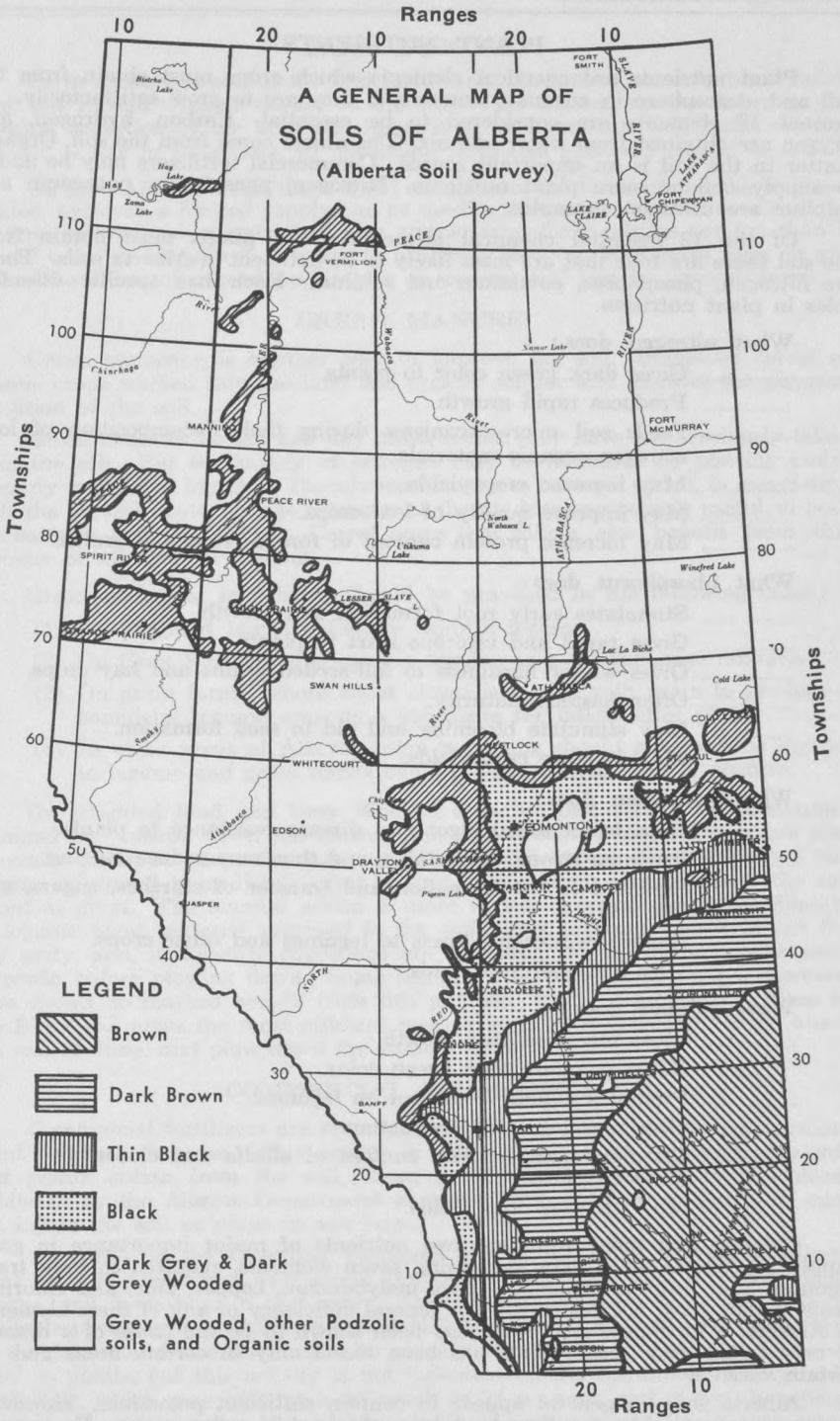
The semi-arid Brown soil of southeastern Alberta covers about 12 million acres. Orthic Brown soils — moderately to well-drained non-saline soils — are dominant in this area. Brown Solonetzic soils — soils with a hard clay subsoil and saline — are sub-dominant. The surface soil horizon is generally light brown to brown in colour. This is a short grass prairie region. Only the finer textured or drought resistant soil types can be considered arable except in districts where the soil is irrigated. Most of the area is desirable for ranching. These soils, however, are not favorable to the growth of legume crops such as clovers and alfalfa, except under irrigation. Moisture is the major limiting factor in crop production. Fertilizers are not generally recommended for dry land farming.

North and west of the Brown soils lie the Dark Brown soils and then the Black soils (thin phase). These groups are approximately equal in size and together cover about 15 million acres. The surface horizon of the Brown soils is generally Dark Brown in color. The upper three to six inches of the Dark Brown are generally Black or very Dark Brown. The Orthic sub-groups are dominant in this area with Solonetzic soils sub-dominant. They were originally grasslands but have become partially invaded by trees, mainly deciduous trees which lose leaves in the fall. Wheat is the principal crop grown but considerable diversification is possible. Legumes such as sweet clover and alfalfa can be grown successfully on these Dark Brown and Black soils. In addition to grasses, sweet clover and alfalfa should be more widely grown to maintain the soil nitrogen and organic matter content.

The Black and Dark Grey soils and the Dark Grey Wooded soils of Central Alberta and the Peace River region cover about 15 million acres. They consist of parkland and areas of continuous tree cover, mainly poplar. The Orthic subgroups are dominant with a significant admixture of Solonetzic soils. Gleysolic soils which occur in poorly drained areas are also present. The Gleysolic soils often have sub-soil mottled with iron straw.

The Black soils have a black to very dark brown surface layer that averages about 10 inches in depth. The Dark Grey soils, characteristic of transition areas between grassland and forest vegetation, are slightly lighter in color than the Black soils. The Dark Grey Wooded soils, found in forested areas, have a grey leached layer under a black surface of about four inches in thickness. Nevertheless, these soils are relatively fertile. These soils are comparatively rich in total organic matter and nitrogen. But they often respond to applications of available nitrogen and phosphorus. Legumes and grasses can be grown successfully on these soils. They should be included in rotation with cereal crops.

The Grey Wooded soils lie west and north of the central area of Black soil and cover about two-thirds of the entire province. The dominant soil is Orthic Grey Wooded. There are, however, significant amounts of organic (peaty) soil, Gleysolic soils, Orthic Dark Grey Wooded soils, and some Solonetzic soils. It is doubtful if more than about 14 million acres are arable. The native vegetation consists of a mixed deciduous and evergreen woodland in which peats frequently occur. The undisturbed soil profile of the Orthic Grey Wooded is usually characterized by a thin surface layer of semi-decomposed leaf litter above a severely leached and bleached grayish layer averaging about six inches thick and a heavier textured underlying horizon. The soils in this zone are very deficient in organic matter and nitrogen. They also are often deficient in phosphorus, and in many areas, deficient in sulphur. It is essential to grow legumes such as clovers and alfalfa, or mixtures of legumes and grasses in order to add nitrogen and organic matter to the soil.


A GENERAL MAP OF
SOILS OF ALBERTA
(Alberta Soil Survey)
Ranges
Townships
LEGEND
Brown
Dark Brown
Thin Black
Black
Dark Grey & Dark Grey Wooded
Grey Wooded, other Podzolic soils, and Organic soils
EDMONTON
CALGARY
LETHBRIDGE
MEDICINE HAT
RED DEER
FORT MCMURRAY
PEACE RIVER
FORT VERMILION
WHITECOURT
EDSON
JASPER
BANFF
DRAYTON VALLEY
SWAN HILLS
SPIRIT RIVER
WESTLOCK
ATHABASCA

PLANT NUTRIENTS

Plant nutrients are chemical elements which crops must obtain from the soil and atmosphere in adequate amounts if they are to grow satisfactorily. At present 16 elements are considered to be essential. Carbon, hydrogen, and oxygen are obtained from water and air. The others come from the soil. Organic matter in the soil is an important source. Commercial fertilizers may be added to supply one or more plant nutrients. Nitrogen, phosphorus, potassium and sulphur are common examples.

Of the 13 essential chemical elements which plants must obtain from the soil there are four that are most likely to be deficient in Alberta soils. These are nitrogen, phosphorus, potassium and sulphur. Each has specific essential roles in plant nutrition.

What nitrogen does:

..... Gives dark green color to plants.
..... Produces rapid growth.
..... Feeds soil micro-organisms during their decomposition of low-nitrogen organic materials.
..... May increase crop yields.
..... May improve quality of leaf crops.
..... May increase protein content of forage crops and grains.

What phosphorus does:

..... Stimulates early root formation and growth.
..... Gives rapid and vigorous start to plants.
..... Gives winter hardiness to fall-seeded grains and hay crops.
..... Often hastens maturity.
..... May stimulate blooming and aid in seed formation.
..... May increase crop yields.

What potassium does:

..... Imparts increased vigor and disease resistance to plants.
..... Produces strong, stiff stalks, and thus may reduce lodging.
..... Essential to the formation and transfer of starches, sugars, and oils.
..... Imparts winter hardiness to legumes and other crops.
..... May increase crop yields.

What sulphur does:

..... Gives increased root growth.
..... Helps maintain dark green color.
..... Promotes nodule formation on legumes.
..... May stimulate seed production.
..... Often increases protein content of alfalfa and clovers by 10 to 25 per cent.
..... May increase crop yields.

Calcium and magnesium are two nutrients of major importance in good supply in Alberta soils. The remaining seven elements, required in only trace amounts, are: iron, manganese, boron, molybdenum, copper, zinc, and chlorine. Tests to date have not yet revealed a general deficiency of any of these elements in Alberta. Manganese deficiency has been shown to be the cause of a disease of oats called grey speck. This has been found only in certain areas and on certain varieties.

Alberta soils in general appear to contain sufficient potassium. However, responses to potassium fertilizer have been obtained in certain areas. Peaty soils are usually low in available potassium.

FARM MANURE

Farm manure is one of the best fertilizers. It supplies not only plant nutrients, but it adds organic matter to the soil. This organic matter improves the physical condition of the land and helps it to hold moisture and resist erosion. Manure is low in phosphate, so phosphate fertilizers generally should be added.

On most Alberta farms there is not enough manure to supply all the fertilizer needed, but even a limited supply can be used to advantage. Spread over as large an area as practical, manure will give greater immediate returns per ton than if spread heavily. Usually it is better to utilize 30 tons on three acres than on one acre. The effect of a good application of manure will last for several years.

GREEN MANURE

Green manuring is another way to improve the soil. Immature cereal or legume crops worked into the land add organic matter and improve the physical condition of the soil.

Green manures do not add any mineral that they have not previously taken from the soil. But the supply of nitrogen may be increased by plowing under properly inoculated legumes. Inoculation introduces bacteria which, in association with the legume roots, change nitrogen of the air into compounds useful to both the bacteria and the legume. Cereal crops that follow also benefit from this increase of nitrogen in the soil.

Green manuring in Alberta should be practised in the following cases :

(1) On irrigated land, preferably using a legume.

(2) On Grey Wooded soils using a legume or a legume-grass mixture.

(3) On grain farms, where sweet clover is seeded with grain to produce a beneficial legume crop as a substitute for fallow after grain.

(4) In other areas of Alberta green manuring should generally be limited to legume and grass stands being broken up from hay or pasture.

On irrigated land and Grey Wooded soils the best results are sometimes obtained by plowing down the entire crop. However, beneficial results are also generally obtained when the hay crop is removed before plowing. When the legume is plowed immediately after haying, the addition of nitrogen to the soil is not as great. The amount added is more or less proportional to the amount of legume plant material returned to the soil. It is probably better to cut the hay early, and, if moisture conditions are favorable, let the legume make some regrowth before plowing down. Some tests in the Peace River region, however, have shown no marked benefit from this practise. Under dry-land conditions in the Black soil areas the most efficient method is to remove the hay early, about the end of June, and plow down the stubble immediately.

COMMERCIAL FERTILIZERS

Commercial fertilizers are manufactured products that contain one or more plant nutrient elements. They supply in concentrated form the same nutrients that plants obtain from the soil. Used in accordance with recommendations published by the Alberta Department of Agriculture, commercial fertilizers cannot injure the soil or crops in any way.

According to the Canadian Fertilizer Act, all materials sold as fertilizers must have a guaranteed analysis of the three major nutrients nitrogen, phosphorus, and potassium, in that order. The available nitrogen is expressed as N, available phosphorus as P_2O_5, and available potassium as K_2O all on a percentage by weight basis. Some fertilizers also contain other nutrients that may be beneficial to plants, but this usually is not indicated on the container. An example is sulphur, which may amount to as much as 24 per cent, and is very beneficial to crops of certain soils. Other nutrients, if present, are usually in very small quantities and are not necessarily beneficial.

From the cost of fertilizers, the cost per pound for each of the various nutrients may be calculated as follows:

For nitrogen (N). One ton of ammonium nitrate contains 670 lbs. of nitrogen (33.5 per cent shown in Table 1). If one ton of ammonium nitrate (670 lbs. nitrogen) costs $74.00, then one pound of nitrogen costs approximately 11 cents.

Similarly with phosphate and potash — using the analysis shown on the bag. It is simple to calculate the number of pounds of each element in a ton of the fertilizer. It is then equally simple to determine the price per pound of the element concerned. In Table 1, below, you will find the guaranteed analysis and the sulphur content of some of the fertilizers sold in Alberta.

TABLE 1.

Information on Some Fertilizers Available in Alberta, 1966.

Name of Fertilizer	Guaranteed Analysis N% (Nitrogen)	P_2O_5% (Phosphate)	K_2O% (Potash)	Sulphur content %
Anhydrous ammonia	82	0	0	0
Nitro-plus	34	0	0	11
Ammonium nitrate	33.5	0	0	0
Ammonium sulphate	21	0	0	25
Urea	45-46	0	0	0
Ammonium nitrate-phosphate	27	14	0	low
Ammonium nitrate-phosphate	23	23	0	low
Ammonium phosphate-sulphate	16	20	0	14
Ammonium phosphate	11	48	0	low
Ammonium phosphate	16	48	0	low
Complete	10	30	10	5
Complete	14	14	7	14
Complete	13	13	13	14
Farm manure	0.5	0.25	0.5	low
Potassium chloride (muriate of potash)	0	0	60	low
Potassium sulphate (sulphate of potash)	0	0	51	20
Gypsum (calcium sulphate)	—	—	—	18
Sodium sulphate (dry)	—	—	—	22
Sulphur (commercial)	—	—	—	98

ANHYDROUS AMMONIA

This high analysis fertilizer (82-0-0) is a suitable source of nitrogen. However, special equipment is required since it is marketed as a liquid stored under pressure in special tanks. The liquid vaporizes on release of pressure. The ammonia gas produced must be applied by means of a special type of applicator, such as a chisel, which places it below the surface. Anhydrous ammonia application sometimes requires a separate operation but this may be combined with soil tillage.

The gas itself can be dangerous. Therefore, it is essential that those working with ammonia know how to use and handle it safely. Operators should wear tight fitting goggles and rubber gloves when making adjustments to any parts of the equipment that are under pressure. Tests to date in Alberta and elsewhere indicate that pound for pound, the effect of nitrogen is the same regardless of the source.

LIQUID FERTILIZERS AND FORTIFIED DUSTS

Tests to date indicate that liquid fertilizers available in Alberta as seed treatments are not effective or economical forms of fertilizers for grains. Liquid fertilizers applied with 2,4-D have not proved profitable for Alberta crops.

Foliar application of fortified dusts, leaf-feeding dust fertilizers or liquid fertilizers are not recommended for economic reasons.

SOIL AMENDMENTS

Soil amendments provide another type of soil improver. They may or may not act as fertilizers. Lime and peat are examples of these materials.

Lime may be used as a soil amendment to correct an acid condition of the soil. As a fertilizer it may serve to supply calcium. Very few Alberta soils need lime. If you suspect that your soil is acid, have your soil tested. A simple test will show whether or not lime is needed. Several soils in the Peace River area and in west-central Alberta have responded to lime but elsewhere in the province soils appear to be well supplied with lime.

Peat may be used to improve the physical condition and moisture-holding capacity of grey soils and clay soils. It also is used to improve moisture-holding capacity of other soils. When properly worked into the soil, well decomposed peat has proved better for this purpose than coarse, light-colored peat. Peatlands are found frequently in the Grey Wooded soil zone. Because of the labour involved in gathering peat, application is usually confined to gardens, greenhouses and other small areas.

Farm manure is one of the best soil conditioners. Because of its value as a fertilizer, it serves two purposes at the same time.

Chemical soil conditioners are available. As yet, the cost is too great to make their use practical on a large scale. Greenhouse operators and home gardeners may find these chemical soil conditioners useful.

FERTILIZERS USE

In a well-managed farming program fertilizers can be a profitable investment. But care must be taken to use the right kind and amount. The use of fertilizers does not, of course, guarantee a good crop. A good growing season with proper amounts of rain and sunshine are needed and the soil must be in good tilth. Fertilizer response thus varies from year to year.

Consult your nearest District Agriculturist, Research Station, Experimental Farm, or the University of Alberta's Department of Soil Science for the latest recommendations regarding fertilizer use.

FERTILIZER PLACEMENT

The most effective use of a phosphate fertilizer is generally made when it is drilled in with the seed. Phosphate does not move readily into or through the soil so it must be placed within easy reach of the roots. Thus, when using a discer or one-way for seeding or when broadcasting fertilizer, extra phosphate is needed to get the same results as when the drilled-in method is used.

Nitrogen, on the other hand, moves readily into the soil. Furthermore, there is a risk of seedling injury if too much is planted with the seed. For wheat, oats, or barley, 25 pounds per acre of the element is considered the maximum safe application for nitrogen drilled-in at planting time. Flax and rape appear to be quite sensitive and 10 pounds N and 20 pounds P_2O_5 are considered maxima for drilled-in applications.

FERTILIZING STUBBLE CROPS

Nitrogen is likely to be an important limiting factor in crops grown on stubble. Phosphorus will usually be in short supply as well. Nitrogen deficiency is indicated by a pale green or yellowish green color and a thin stand of crop. The appearance of the previous crops, therefore, can be used as a guide as to whether or not to use nitrogen fertilizers. In some areas, especially in the drier parts of the province, heavy trash maintained on or near the surface to prevent wind erosion will usually result in a need for nitrogen fertilization.

In the drier-parts of the province where fallowing is practised to conserve moisture, it must be kept in mind that stubbled-in crops are more likely to suffer from drought. This, coupled with the fact that the response of a stubble crop to nitrogen depends to a large degree on the growing conditions, means that the increases in yields resulting from fertilization will vary over a wide range.

Experiments conducted on the Black and Dark Brown soils of Alberta since 1956 have shown that about two-thirds of the grain crops tested on stubble gave profitable returns from nitrogen fertilizers when used in combination with phosphorus.

Since some remarkable yield increases have been obtained by fertilizing stubble crops, it is important that farmers study their cropping program carefully. If spring reserves of sub-soil moisture are good, if previous crops have shown symptoms of nitrogen deficiency, and if the market value of the crop is good, an investment in a nitrogen fertilizer would likely pay dividends. The recommended practise is to broadcast the nitrogen fertilizer and drill-in phosphate with the seed.

SOIL TESTING

A chemical soil test is sometimes helpful in selecting the right fertilizer. The Alberta Department of Agriculture operates a soil testing laboratory where farmers may have their soils analyzed at a nominal cost. For most meaningful results, soil samples have to be collected very carefully. In addition, the analyst needs some basic information on the cropping history.

Your District Agriculturist can give you detailed instructions on how to take your samples, how and where to mail them, and information that needs to be supplied.

Analytical results are mailed out accompanied by some practical suggestions. During rush seasons several weeks should be allowed for the processing of your soil samples.

FERTILIZING SPECIAL CROPS

Potatoes (non irrigated) on Fallow

Tests so far suggest the use of 11-48-0 at 100 to 200 lbs./acre. The fertilizer should be placed in bands an inch or two below and to the side of the seed pieces. Potash may be needed on some soils for increased yields. A soil test may be helpful in this regard.

Gardens and Lawns

Any of the fertilizers containing nitrogen and phosphorus can and should be used on gardens and lawns. For complete information write to Department of Extension, University of Alberta, Edmonton. Ask for Bulletin S-M-2, "Soils and Fertilizers for Gardens and Lawns."

REFERENCES

	Bulletin Number	Agdex Number
University of Alberta :		
Colored Soil Zone Maps		590
Grey Wooded Soils and Their Management	21	512/1
Soils and Fertilizers for Alberta Gardens and Lawns	S-M-2	540/208
Alberta Department of Agriculture		
Soil Management in Alberta	155	510
Fertilizer Recommendations for Alberta	541	541
Canada Department of Agriculture		
Soil Management Practices in the Upper Peace River Region	985	512

SOIL MANAGEMENT

SOIL DRIFTING

High velocity winds, sweeping across a pulverized soil surface, dislodge fine particles. These in turn dislodge and rub off other particles and drifting increases. Very fine particles are transported considerable distances. The larger, less fertile, particles are deposited along fence rows and in ditchs.

Soil drifting can occur at any time. It is a major hazard on the brown and dark brown soils of Alberta in the spring and fall months. An additional hazard arises in the "Chinook Belt" during the winter when warm winds remove the snow. Black and Grey Wooded soils are subject mostly during the spring.

The threat of soil drifting is not limited to periods of below-normal precipitation although continued drought makes the hazard worse.

CONTROL PRACTISES FOR SOIL DRIFTING

Trash Cover Farming. Trash cover farming, properly carried out, provides a **most effective long-range control practise** for use on grain farms. It is defined as a system of managing cereal stubbles and other plant residues to protect the soil from erosion. Excellent protection is obtained if 1,500 to 2,000 pounds of trash per acre are maintained on the surface of a fallow field and if a major portion of this cover is carried on a seeded field. Spring wheat produces about 100 pounds of straw and stubble with each bushel of grain in the Dark Brown soil zone. This is slightly less in the Brown soil zone, and somewhat more in the Black and Grey Wooded soil zones.

Tillage Machines

Successful trash cover farming is dependent on the wise choice and use of tillage and seeding equipment. Generally, the various tillage machines reduce the surface trash cover by the following amounts each time the machine is used:

Wide-blade cultivator	5 to 10 per cent
Rod weeder	0 to 10 per cent
Heavy-duty cultivator	15 to 25 per cent
One-way disc and discer	40 to 60 per cent

High Speed

High speed operation at shallow depth with the heavy-duty cultivator can bury up to 50 per cent of the surface trash. Deep tillage with disc machines can bury more trash than indicated above. However, disc machines can be operated one to two inches deep to chop but not bury heavy residues. The trash harrow or the mulch-treader can be used to break-up and spread heavy quantities of straw. They work best on dry, brittle residue and should only be used when a heavy trash cover exists.

Seeding

Seeding machines equipped with double or single-disc furrow openers will provide proper seed placement through not more than 2,000 pounds per acre of well-spread cereal residue. Stubble-mulch drills equipped with hoe-type or shovel-type furrow openers will operate satisfactorily through nearly 4,000 pounds per acre of trash. The one-way disc with seeder attachment will also handle large quantities of stubble. Packing obtained by using a press-wheel carriage seeder or a packer attachment behind the one-way disc seeder is essential when seeding trash-covered fields.

Summerfallow

The summerfallowing of land that has produced a normal or a below-normal crop requires careful use of tillage machines to keep maximum trash on the surface. The combine stubble should be cut as long as possible and the straw uniformly scattered by the spreader attachment. A sub-surface cultivator should be used for all tillage operations. Seeding may be done with either a double-disc press drill or a hoe drill.

When summerfallowing land that has produced above-normal crops, use the combine straw chopper attachment to cut up and spread straw. This is particularly advisable when harvesting flax. One or two discing operations may

be used during the fallowing and seedbed preparation period, particularly when weed control is difficult. Otherwise, use the sub-surface cultivator for tillage, the trash harrow or a mulch treader during seedbed preparation, and the hoe drill for seeding.

"Stubbling-in" land with normal or below-normal quantities of stubble and straw may be done with the one-way disc seeder and packer. Where extra tillage is required for weed control, use the cultivator or disc followed by rod weeding if required. Either the double-disc press drill or the hoe drill can normally be used. Land with a very heavy stubble cover (4,000 pounds or more) will require extra effort to prepare a "stubble-in" seedbed. A disc-type implement can be used to chop the straw and disc-in the stubble. A mulch treader, if available, can be usefully employed to complete the seedbed. The hoe or shovel drill should be used for seeding. Otherwise, additional tillage will be needed to prepare the seedbed for a double-disc drill.

Burning stubble, or windrowed straw, is **not** justified. Equipment and procedures are available that will take care of any level of trash that may be encountered. Continuous use of burning increases the erosion hazard and will eventually reduce soil fertility.

EROSION CONTROL

(a) **Clod structure** on fallow supplements trash cover as an erosion control aid. Timeliness of tillage with respect to soil moisture is a factor in maintaining some clod structure. Disc implements should not be pulled at a high speed. Chisel plows and under certain conditions the duck-foot, heavy-duty cultivator and rod weeder can be used to establish a cloddy condition.

(b) **Ridging** with a cultivator crossways to the prevailing winds is very effective in reducing wind erosion.

(c) **Strip cropping** has proved valuable, particularly when combined with trash cover. Narrow field strips reduce the spread of drifting from focal points in a field. Strips from five to 16 rods wide are recommended on sandy and clay soils. On loam, silt loam, clay loam, and silty clay loam, strips 16 to 20 rods or slightly wider have been successfully used. Strips should be at right angles to the prevailing wind. If conditions are suitable, contour stripping may be practised.

(d) **Good shelterbelts** decrease wind velocity for a distance to the leeward of up to 20 times the height of the belt and for a short distance to the windward side. Increased crop yields to the leeward of shelter belts may be attributed to increased moisture conservation. In park belt areas, adequate shelter belt strips should be left to prevent serious wind erosion.

Shelterbelts are planted at right angles to the prevailing wind and at a distance of 20 to 40 rods apart. Contour planting of shelterbelts, combined with grassed strips and grassed water runways, is useful for both wind and water erosion. Keep tree belts at least eight to 10 rods from a road allowance to avoid blocking roads in winter and follow regulations with respect to planting belts next to highways. For information on trees and planting procedure, see the section on tree planting.

(e) **Cover crops** to protect soil and provide fall pasture are used in moister areas including parts of the dark brown soil zone. Oats are seeded on fallow late in July at a rate of three-quarters to one bushel per acre. Overgrazing destroys protective value of the cover. On irrigated land a cover crop, seeded on sweet clover or canning pea land after the clover is plowed under or the peas are harvested, will protect the soil and provide fall pasture.

(f) **Sandy soils** do not form weather-resistant clods and are very subject to drifting.

In dry regions, seeding sandy areas to permanent pasture is strongly recommended. Strip cropping in narrow strips (five rods) or less and maximum trash conservation must be used where sandy soils are summerfallowed. In drought years, trash cover from weed growth and the use of deep listing may be required to prevent or control erosion.

(g) **On irrigated land** many cropping systems do not lend themselves to trash cover farming. Pasturing off crop residues such as beet tops and corn stovers predisposes soil to drifting because of the trampling by cattle and sheep.

Fall irrigating and subsequent fall plowing when soil moisture is conducive to clod formation is recommended. Fall-plowed land should not be disced and harrowed. Fields unsuited to fall plowing, e.g., sandy and heavy clay soils, should be shallow chiselled to roughen the surface. Cover crops should be used where practical.

EMERGENCY CONTROL

Winter Drifting

(1) Winter drifting can be controlled by shallow chiselling with a heavy-duty cultivator with every other shank removed. Light tool-bar cultivators may be severely damaged if used in frozen soil. One-way discs with three out of four pans removed make excellent listers for frozen soil. The use of chisel blades on the shanks of a wide-blade cultivator, or other methods of plowing light furrows every six to 10 feet, will help check drifting on a winter wheat field and save the crop. Spreading manure or straw on small focal points will frequently check soil movement.

Unfrozen Soil

(2) Drifting of unfrozen soil can be checked by any tillage operation that produces a rough cloddy condition. Chisel plows and other cultivators may be used. Plowing furrows around a field at frequent intervals helps. Under severe conditions, listing is required. Lister furrows, formed with a one-way lister or a cultivator with alternate shovels removed and the remainder steeply pitched, should be 24 to 30 inches apart. If sufficient soil has been trapped to fill the furrows, the listing operation should be repeated.

WATER EROSION

Erosion Causes

The severity of soil losses from water erosion depends on rainfall, erodibility of the soil, protective trash and topography.

Intensity and total amount of rainfall determine the potential erosion effect. A soil can absorb water at a given rate until it becomes saturated. If the intensity of rainfall is more than the rate of infiltration then run-off and possible erosion occur. In addition, raindrops pulverize exposed soils liberating clay, silt and fine sand particles to be carried away in the run-off.

Average annual precipitation in Alberta's crop-growing areas varies from 13 to 20 inches, 70 - 80 per cent of which falls during the period April 1 to September 30. Usually rainfall is well distributed and rarely are our soils filled to capacity.

The few records available indicate that rainfall intensities in Alberta are low compared with those in areas where water erosion is severe. The record 24 hour rainfall was 4.83 inches reported at Thorsby, Alberta, in July, 1937. Many of the south-eastern United States report storms delivering over 10 inches in 24 hours. Flash storms in Alberta have delivered less than two inches per hour compared with up to five inches in other parts of the world.

Soil structure depends on the relative amounts of sand, silt and clay, the amount of organic matter, the chemical nature of the soil and cultural practises. Soil structure affects the severity of erosion since it controls rate of infiltration of water and stability of the individual soil granules. Impervious layers close to the soil surface prevent infiltration and cause run-off.

A protective trash cover, growing crop or adding materials as manure, break the striking force of the raindrops. They also act as a series of dams to control water run-off.

Slope of land will determine the type and severity of erosion likely to occur.

Soil Losses from Water Erosion

Since total rainfall and intensity of rainfall in Alberta are low, there is a tendency to disregard water erosion completely. However, both gullying and sheet erosion are severe in parts of Alberta. Sheet erosion on long uniform slopes has been particularly commonplace in the Peace River District. Gullying has oc-

curred throughout the province, generally in years of heavy spring run-off. Both types of erosion result in the loss of fertile top soil. In addition, the gullying presents a hazard to machine operators, a hindrance to cultivation and a weed trap.

Control Measures for Alberta

(1) Follow a cropping pattern that will maintain the organic matter in the soil and good soil structure.

Avoid summerfallowing wherever it is not necessary (see section on moisture conservation). Maintain a trash cover on the soil surface when land is not in crop. Do not pulverize the soil unnecessarily and do not burn straw or stubble.

(2) Seed down waterways with a mixture including a grass. Where severe gullying has occurred, waterways may be filled and re-grassed. (See Gully Filling and Improving Water Courses.)

(3) Keep steep slopes in permanent grass or tree cover. Regrass or reforest where necessary.

(4) Practise strip cropping across slopes of cultivated fields that tend to wash severely. Contour cropping may occasionally be required. Do cultivation across rather than up and down slopes. A ridged surface left in the fall across a cultivated slope will tend to check spring run-off.

(5) Grow cover crops or winter crops on fields that are likely to be damaged by spring run-off.

MOISTURE CONSERVATION

Moisture Limits Crops

Moisture is the main factor limiting crop production in the south and east central areas (Brown and Dark Brown soils) of Alberta. The average annual precipitation is about 13 inches with frequent dry winds reducing the effect of the rainfall. To the north and west (Thin Black soils) the average annual precipitation varies from 14 to 16 inches. Due to lower average temperature and less wind, each inch of rainfall is more effective here than in the Brown and Dark Brown soil zones.

Soils differ considerably in their capacity to store moisture. Clay soils can store more than twice as much as sandy soils. This, in part, explains the greater drought resistance of clay soils.

One purpose of summerfallowing is to store moisture for the following crop. The soil surface during fallow must allow for easy entry of water by maintaining trash cover and ridging the field parallel to slopes. Fallow land should be kept weed free to prevent loss of the stored moisture. Every inch of moisture conserved means extra bushels in next year's crop.

The depth of moist soil in a stubble field may be determined with an auger. The change from moist to dry soil is easily observed. Moist soil will form a ball when squeezed in the hand. Dry soil is lighter in color and is harder to bring up with the auger. It will not form a ball. In the Brown and Dark Brown soil zones, less than 27 inches of moist soil at seeding indicates a poor reserve. It is insufficient for a satisfactory crop in the average season.

On Black or Grey Wooded soils fallowing for moisture storage is not necessary because of greater rainfall and less evaporation. In these soil areas, fallowing should be practised only for weed control or when breaking sod crops.

SPECIAL PROBLEMS

Saline and Alkali Soils — See section under Irrigation

Solonetzic Soils :

Solonetzic soils (sometimes called burn-out, blow-out or gumbo soils) developed in earth material that originally was saline to the surface. A high percentage of the salt was sodium sulphate. This initial condition, as far as areas in Alberta are concerned, existed five thousand to ten thousand years ago. Rain water through the years has washed the salts out of the top portion of this material and carried them down to the lower levels.

During this leaching process there developed a very hard, usually alkaline, subsurface or B horizon. The surface or A horizon remained easily crumbled to powder or friable. This process is still going on but at a very much slower rate than in the early stages of development. The depth of the friable A horizon and the depth and hardness of the B horizon are indicators of the stage of development of the soils. They are also indicators of the relative desirability of this group of soils for crop production.

Solonetzic Soils

Solonetzic soils with a sharp break between the A horizon and the hard, (usually round-topped) columnar B horizon, are called Solonetz. These can be subdivided into those with a thin A horizon and those with a thick A horizon. Those soils in which the hard B horizon is beginning to break down are called Solods. This breakdown is particularly noticeable in the upper part of the B horizon. The columns are fairly easily broken into small cubes. There is, therefore, in the Solod a gradual change from the friable A to the hard B horizon, as contrasted to the abrupt change in the Solonetz. With continued breakdown of the hard B horizon, the soil tends to be more like the normal, or Orthic soils of the area. In this case they are referred to as Solodic. In general, going from Solonetz to Solod to Orthic there is gradual deepening of the A horizon and the salts occur lower down the profile.

Solonetzic soils usually occur as a complex mixture of the various members, along with both normal and saline soils. Internal drainage is restricted in all solonetzic soils, being most restricted in the Solonetz. Indeed, it is doubtful if solonetzic soils could have developed with a good internal drainage. Productivity varies greatly throughout the complex, being greatest on the patches of Orthic or Solodic soil. Salt influenced the type and quantity of native vegetation, and this probably provides part of the explanation for the present variable quantity of organic matter in the A horizon.

The most extensive solonetzic soils area in Alberta is about 375 miles long and about 50 miles wide. It extends from north-east of Edmonton to west of Medicine Hat. A large area of Solonetz and associated soils also occurs in the extreme south-east corner of the province. They occupy an area approximately 50 miles square. Other significant areas where solonetzic soils occur are in the Peace River region and in the vicinities of Leduc, Clyde, Cardston, Coutts, and Chancellor.

In addition to their wide area of occurrence, solonetzic soils have a wide range of chemical and physical characteristics. Thus, although these soils are considered to be inferior to normal soils, success of cropping varies from fairly good to poor, depending on management.

Studies conducted on the Soil Research Sub-Station at Vegreville, Alberta, have shown that management and fertility are key factors in improving crop productivity on Solonetzic soils. The removal of excess surface water is very important. It can often be accomplished by opening water runs with the one-way or even with a little shovelling. The development of a fine-firm seed bed is important but often difficult to achieve. Seed bed preparation is made easier by the removal of excess water, However, the amount of preseeding tillage required still varies from year to year.

There have been some reports that very deep working improves the structure and is thus beneficial on Solonetzic soils. However, research has shown that in the Black soil zone working to a depth greater than four to six inches has not appreciably increased yields. In some cases (such as 14-inch plowing) it has created a problem in seed-bed preparation. Bringing the plastic B horizon to the surface increases soil puddling and baking. Sufficient research has not been conducted in the Dark Brown soil zones however, to rule out deep working as a soil improvement practice.

Experience has shown that the inclusion of forage crops in the rotation will improve the structure of Solonetzic soils in the Black soil zone. Most of the common grasses can be grown on well managed Solonetzic soils. Seven were compared at Vegreville for five years. Brome, intermediate wheatgrass, and creeping red fescue gave approximately equal average yields. However, there were considerable differences in the distribution of production within seasons and over the years. For instance, intermediate wheatgrass gave greater production than brome

in the seeding year, but considerably less in the fourth and fifth years. Crested wheatgrass, reed canary, meadow fescue and timothy gave lower production than the three grasses discussed above.

Alfalfa is readily established on these soils. However, the contribution it makes to yield is determined by the severity of the solonetzic condition. On the more productive soils it produces well. But on the less productive soil, the plants are spindly and low producing. It is suggested that a small amount of alfalfa be seeded in a mixture as it may contribute somewhat to the yield of the first year hay. However, fertilization should be aimed at increasing yield of grass, rather than alfalfa.

Research has shown that a given volume of topsoil from a Solonetz area will not release a quantity of nitrogen approaching that released by the same volume of topsoil from a normal soil. The situation is even worse than the simple lack of nitrogen release per unit volume. There is often less than half as much topsoil — (four inches or less in depth — on a Solonetz as on a normal soil eight inches or more deep). Essentially, all the release of nitrogen occurs in the topsoil layer.

This lack of fertility severely limits forage crop productivity on solonetzic soils. At Vegreville, the four-year average yield of brome hay was increased from 1,308 pounds per acre where no fertilizer was applied to 5,991 pounds where 270 pounds of nitrogen was applied per acre per year. Sixty-seven pounds of nitrogen per acre per year (the suggested rate) provided a yield of 2,860 pounds of dry matter per year.

There is some danger of causing "nitrate poisoning" in livestock by using excessive rates of nitrogen fertilizer. Until the problem is better understood, the use of more than 70 pounds of nitrogen is not suggested.

The same cereal crops that are recommended for a normal soil for a given district can be grown successfully on a solonetzic soil in the same district. However, for stubble crops, preference should be given to fertilizers containing high ratios of nitrogen to phosphorus.

Peats — In Alberta, peat soil occurs mainly in the Grey Wooded soil zone. However, there are numerous minor areas in the Dark Grey Wooded and Black soil zones. It is estimated that peat covers 25 million acres in Alberta. But few of the great muskegs in Northern Alberta will likely be reclaimed for agricultural use. However, many small areas in the settled part of the province have been brought under cultivation.

The peats are usually underlaid by clay or other soil material fine enough to hold the moisture in basins or flats, which permitted and encouraged the growth of sphagnum moss and other moisture-loving plants. Most of the Alberta peats studied have been classified abroad as high moor or moss peats, but they are commonly called muskegs in this country. Alberta peats, classified as lowmoor, sedge or grass peats, are usually shallow, rich in lime, dark in color, and some are relatively fertile.

Alberta peats vary from about pH 4.0 on the acid side, to about pH 8.5 on the alkaline side. A pH of 7.0 is neutral. Many crops grow poorly or not at all when the pH is 5.0 or lower. Addition of lime to soils with a low pH will make them more productive.

Experimental work with peats has not been carried on long enough in Alberta to be certain of the best methods of bringing them under cultivation. The first step, naturally, is to drain the land. However, it should be realized that the draining of peat bogs, like the clearing of forests, dries up reserve moisture in dry seasons. In their undrained state, peat bogs form natural reservoirs and feed the streams that would otherwise dry up in droughty seasons. Peat bogs should not be drained unless the land is to be reclaimed for pasture or other crop production.

Burning should not be practised in reclamation of peat bogs. In addition to the questionable benefit of burning stubble and trash, there is danger of the peat itself catching fire. If this occurs, the fire will become very difficult to extinguish and may burn for years with the result that the surface will be left very rough and unsuitable for cultivation. Occasionally, when the peat layer is shallow, an attempt is made to burn it off and so expose the clay soil beneath. This subsoil is very difficult to work and often is very unproductive.

Tillage of peat soils presents problems somewhat different from those on normal soils. Peat soils may be broken by a moldboard plow or a heavy rototiller. Subsequent tillage operations will cause the surface to "fluff" excessively. This makes further tillage or seeding difficult until the surface has been compacted. Thus, it is recommended that a heavy, smooth packer be used after each tillage operation to firm the soil surface.

Frost damage is more frequent on peat soils than on adjacent mineral soils because less heat is radiated from peat on cool nights. In addition, peat commonly occupies lower areas into which cold air drains. The soil is also slower to warm in the spring. With this combination of factors, forage crops should be grown on peat soils. At the Leslieville Experimental Project Farm, the frost free (28° F.) period in 1965 was 103 days. The four year average was 87 days. A frost (32° F°) can be expected at this location in every month of the year. Despite this severe restriction, nearly three tons per acre of brome grass was produced on fertilized plots in 1964.

Reclaimed peat land should be seeded to a mixture of grasses and clover. This crop is the easiest to manage and will provide the surest return. On poorly drained areas or areas subject to periodic flooding, reed canary grass is best. On well-drained areas, timothy, brome and alsike clover may be grown successfully. Early maturing oats or barley may be grown for grain or harvested as green feed.

Recent tests indicate that moderate rates of fertilizer on hay meadows produce economic increases. Deficiencies varied from straight nitrogen at several locations, nitrogen-phosphorus at others and phosphorus potassium at one location. Sulphur was found beneficial for legumes on some peat soils. Field test plots would determine the required fertilizer combination.

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IRRIGATION

HISTORY

Irrigation in Alberta developed its first major project in 1901 when the Alberta Railway and Irrigation Company completed the main works to divert water from the St. Mary river at Kimball, Alberta. This diversion provided irrigation for about 600 acres of land near Lethbridge and 3,000 acres in the Magrath district.

The governments of Alberta and Canada and the Canadian Pacific railway have developed the major irrigation projects in Alberta. Small projects have been developed by individuals and through the assistance of the Prairie Farm Rehabilitation Administration.

At present, irrigation works are owned and operated by either the governments or the farmers.

Water Supply

(1) The ownership of all surface waters is vested in the crown. These waters or the right to their use cannot become private property.

(2) The use of water is regulated by licenses from the crown which can be cancelled for non-use or misuse.

The supply of water for irrigation use in Alberta is adequate for all the projects now operating. Alberta also is fortunate that its topography is well adapted to gravity diversion.

The greatest demand for irrigation water coincides quite closely with the period of peak run-off from the melting snows of the Rocky Mountains. Water needs for autumn irrigation are taken either from a river or off-river storage.

Legal Duty of Water

The legal duty of water for the irrigation season May 1 to September is 18 inches. This is the amount of water legally diverted at the farm for irrigation. But some of the irrigation districts have diverted much more than this. Some of the earliest canals were designed to supply one cubic foot per second for every 150 acres during the irrigation season.

Not counting water losses, such a flow would provide a total of 24 inches depth of water for an area of 150 acres. This would occur if the water users applied a continuous supply of water 24 hours a day during the entire irrigation season.

This design naturally restricted the rate of water flow needed to maintain uniform crop growth in a farm unit. This was because all the irrigation area needs water in a reasonably short period to prevent deterioration of crops.

The generally accepted minimum use is at the rate of 2.5 cubic feet per second or five acre-feet per day. This volume applied to lands in depths of four to six inches will irrigate 10 to 15 acres per day. At this rate, 160 acres will be irrigated in 12 to 16 days. This rate of required flow is about twice that provided in the original irrigation regulations.

On many of the earlier projects, the structures were inadequate. Experience has shown that while sound construction is expensive, it is best in the long run.

The use of water for irrigation is classified as water used by a consumer. It has preference over water used for power or recreational use. However, irrigation water is second choice to the use of water for home, municipal or industrial use.

Sources of Water

All of Alberta's major irrigation projects get their water supply from the South Saskatchewan river or its tributaries. The more important tributaries are the Old Man, Waterton, Belly, St. Mary, Highwood and Bow.

The water supply for the St. Mary's River Development project is also affected by the use of water in the United States. The Americans divert water from the St. Mary river to the Milk river across the border. This water flows down the Milk river channel and is later re-diverted near Havre, Montana.

The sharing of the water of the Milk and St. Mary rivers is governed by treaty. No agreement has been reached on the sharing of the waters from the Waterton and Belly rivers which arise in Montana and flow through the prairies to Hudson Bay.

Because irrigation represents a consumer's use of waters, the downstream provinces on the Saskatchewan basin are concerned about proposed additions to irrigation developments in Alberta.

This concern in Saskatchewan and Manitoba has moderated in recent years. This is because of the construction of oil and gas pipelines bringing hydrocarbon fuels to the two provinces. In addition, there has been a lessening of emphasis on the use of the Saskatchewan River delta at La Pas for fur production. Instead, there is an increasing demand to use this fertile land for agriculture by diking and drainage.

There is, however, a definite limit to the acreage that can be irrigated. In years to come there will be a close scrutiny of the amount of water used in this province. The number of water stations is being steadily increased not only to measure supply, but also actual diversions to the various projects. In the case of irrigation works, the return flow to the rivers also is measured.

Prairie Provinces Water Board

The Saskatchewan river flows through the three prairie provinces, and in order to apportion the waters of the river a board was established in 1948 known as the Prairie Provinces Water Board. Each province has one representative on the board, and the federal government has two representatives. Although the board is an advisory organization, it has the power to make allocations of water after each province has approved the allocations by appropriate orders-in-council. Alberta has been allocated 2,237,234 acre-feet of water to irrigate 1,256,453 acres.

Irrigation Benefits

Assistance in the preparation of plans is available to farmers through the Alberta Department of Agriculture, Land Development Branch. The local contact for the farmer is the district irrigationist.

Benefits of a well-developed irrigation system are :

(1) a uniform application of water.
(2) earlier seeding;
(3) uniform and higher yield;
(4) water continuously under control, which reduces waste of water and land;
(5) erosion control;
(6) prevention of salinity, alkali, and water-logging;
(7) low labour requirement;
(8) high irrigation efficiency;
(9) greater choice of crops;
(10) increased land value; and
(11) improved general appearance of farms.

Land Preparation

Land levelling should be arranged well in advance of operations. The most suitable time for land levelling is from May to October. Enough time should be allowed to cultivate, float, and fall irrigate the levelled land.

Summerfallow is the most suitable for land levelling as trash impedes earth moving and floating operations to a certain extent. Flax stubble is especially cumbersome as it balls up. As a result, earth moving machines take longer to load. Stubble and alfalfa land should not be worked prior to land levelling unless self-loading equipment is going to be used in the levelling operation.

Following land levelling operations, cut areas should be chiselled at least three times to a depth of six to eight inches to increase infiltration and help reduce the effect of the packing action of heavy earth moving equipment. Levelled

fields should be prepared for fall irrigation by floating and the use of corrugations to prevent erosion and ensure complete water coverage. Fall irrigation will assure a moisture supply for the following spring, help settlement of fill areas and control soil drifting.

Permanent crops should not be planted the first year following heavy earth moving as trimming is often required after irrigating. Some fill area may settle and some cut areas may swell. The spring operation should include re-working, floating and seeding to an annual crop. The land can be border dyked and if floating is not required after the crop is harvested, the stubble can provide protection for the seeding of forage crops.

Barnyard manure should be applied at the rate of at least 10 tons per acre. In addition, with cereal crops the first year apply 100 pounds of 16-20-0 fertilizer. Established legume crops should receive 100 pounds of 11-48-0 fertilizer in the early spring. If barnyard manure is not available, a green manure crop of innoculated sweet clover may be grown. Where only fertilizer is to be used, apply 200 pounds of 27-14-0 for cereal crops the first year and if legumes are grown the second year, apply 100 pounds of 11-48-0.

Barnyard manure and legumes will also improve the physical properties of the soil.

Structures

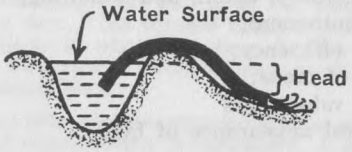
Structures for control in checking, diverting, or dropping of water can be built of treated wood, concrete, or other material and properly located in ditches to ensure savings in labour, water and land.

Syphon Tubes

Syphon tubes and similar equipment provide control of water application as well as reducing labour and ditch bank maintenance at take-out points along the head ditch.

Volume Flow Per Syphon Tube in Gallons Per Minute

Head	3 inches	4 inches	6 inches	9 inches
Tube Diameter in Inches				
¾	4	5	6	7
1	6	7	9	11
2	27	32	41	50
4	106	122	153	200



Syphon Tube use.

METHODS OF IRRIGATION

The method of irrigation depends upon the crop to be grown, the type of soil, the slope of land, and the amount of available water.

Free Flooding From Contour Ditches

Free flooding from contour ditches is used on rough land with variable slopes where better methods cannot be used. The spacing of ditches and the handling of the water by the irrigator are very important. Contour ditches drop at the rate of one to three inches per 100 feet of length and are spaced from 75 to 300 feet apart. The wider spacing is recommended for heavier soil and flatter slopes.

Water Measurement

Water measurement is easily made with the provision of one or two well-installed measuring structures in the farm ditches. It is important to know how much water is being applied on each irrigation run during any period of time.

Cubic foot per second (c.f.s.) — This is a rate unit and represents an exact and definite quantity of water per second. It is the equivalent of a stream one foot wide and one foot deep flowing at an average rate of one foot per second.

One cubic foot per second =

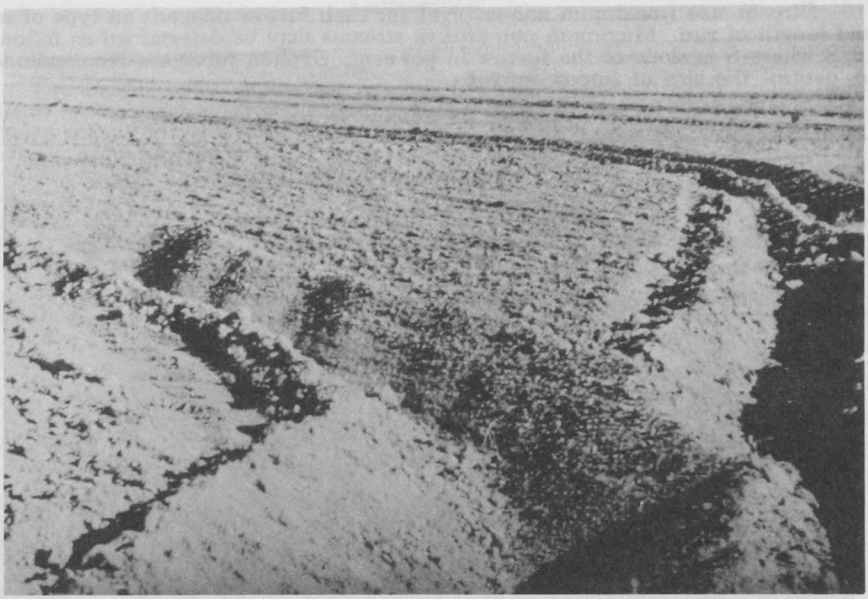
one acre inch in one hour (approximately).
one acre foot in 12 hours (approximately).
450 U.S. gallons per minute (approximately).

One cubic foot = 7.48 U.S. gallons = 6.23 Imperial gallons
1 U.S. gallon = 0.83 Imperial gallons

Acre-foot — An acre-foot is a volume of water sufficient to cover an acre one foot deep. It is equal to 43,560 cubic feet or 325,851 U.S. gallons.

Acre-inch — An acre-inch is a volume sufficient to cover an acre one inch deep.

One acre-inch = 27,154 gallons (U.S.) = 3,630 cubic feet



Contour Ditches.

Border Ditches

Border ditches running parallel down slopes are used on gentle slopes. The careful spacing of ditches determines the effectiveness of this method.

Border Ditch Irrigation

Soil Type:	Sand	Loam	Clay
Ditch Spacing	50 - 100 feet	50 - 150 feet	50 - 250 feet

Border Ditches.

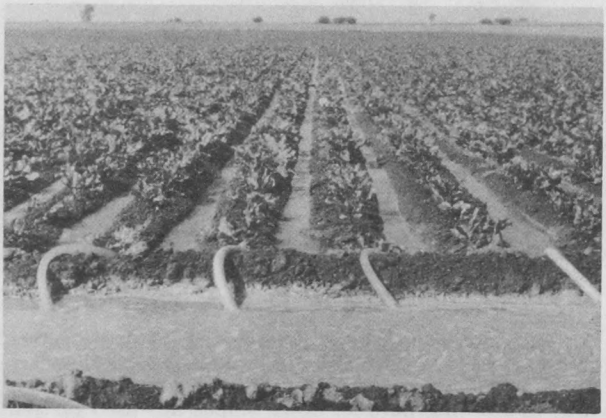
Furrow Irrigation

Furrow irrigation is used for all row crops with slopes not exceeding two per cent. Where slopes exceed one per cent, cross slope or contour furrows are suggested to reduce the furrow slopes.

Stream size (maximum non-erosive) for each furrow depends on type of soil and length of run. Maximum non-erosive streams may be determined as follows: 10/S where S is slope of the furrow in per cent. Syphon tubes are recommended to control the size of furrow streams.

Length of Furrow Runs

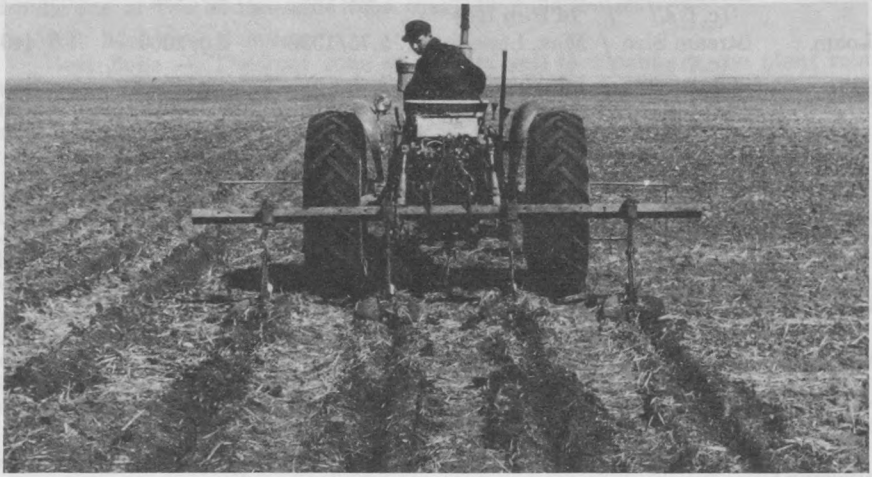
Soil Type	0.2 to 2 per cent Slope Feet
Sand	660 - 265
Loam	880 - 440
Clay	1,320 - 660



Furrow Irrigation.

Corrugations

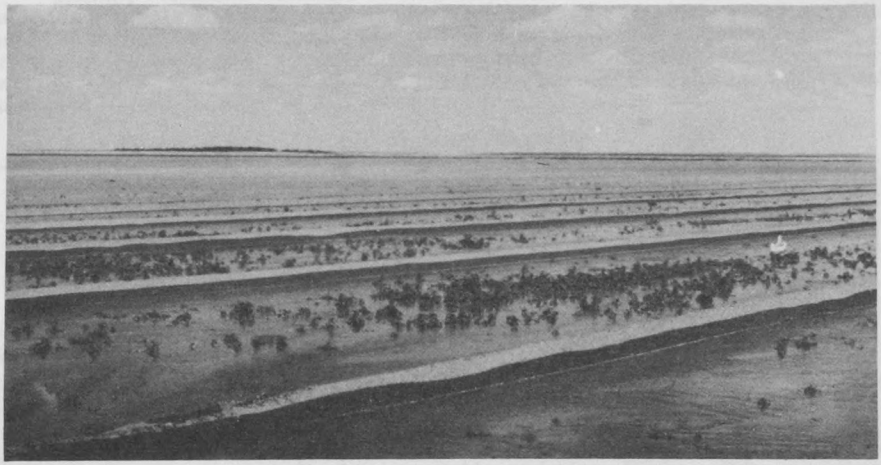
Corrugations are small furrows used for broadcast or close-seeded crops on lands of varying topography. This method is particularly useful for irrigated pasture crops on steep or irregular slopes or if only a small stream of water is available. Slightly smaller stream sizes and shorter lengths of run are used for corrugation irrigation as compared to the furrow method. Corrugate spacing varies from 24 to 36 inches.



Corrugation.

Border Dykes

The border dyke method of irrigation is most efficient requiring the least amount of labour, yet irrigates the land at the fastest rate. It is highly recommended for all close-seeded crops, especially hay and pasture. Only one head ditch for each field is required for irrigating by this method. The dykes are six to 12 inches high and 2.5 feet wide, being located from 16 to 50 feet apart running parallel down the slope. The space between each pair of dykes is called a border which provides the irrigation run. Dyke spacing depends on type of soil, steepness of the land, available stream size and cross slope. The table recommendations are based on an intake rate of: sand — 1.1 feet per hour; loam — 0.75



Border Dykes.

inches per hour; clay— 0.4 inches per hour. The recommended stream size is without cover and should be increased by 50 per cent when the crop has been established.

Border Dyke Irrigation — 33 Foot Dyke Spacing

Downfield Slope (per cent):		0.6	1.0	2.0
Sand	Stream Size (c. f. s.) / Max. Length of Run (ft.)	3.0/880	2.0/660	1.0/400
Loam	Stream Size (c. f. s.) / Max. Length of Run (ft.)	2.75/1320	2.0/1000	1.0/440
Clay	Stream Size (c. f. s.) / Max. Length of Run (ft.)	2.75/2640	1.75/1320	0.9/440

Sprinkler Irrigation

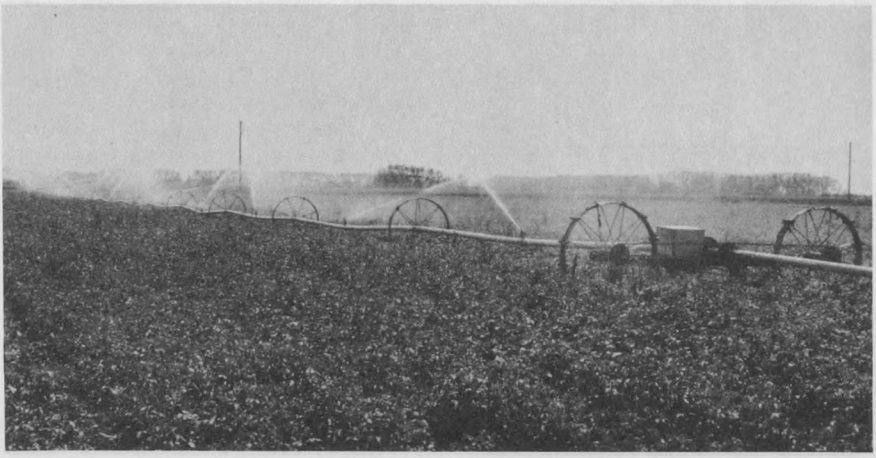
Irrigation by overhead sprinkling has become increasingly popular in Alberta within the last 10 years. There are probably many reasons for this, but some of the more important ones are the scarcity of skilled labour for flood irrigation, improvement in design and mechanics of sprinkler systems, and off-season rates to provide cheap sources of power, especially natural gas and electricity.

When buying a sprinkler system, it is of prime importance to have the system designed specifically for the job that has to be done. Pump and motor must be selected for top level efficiency and low maintenance cost. Pipes must be sized to prevent excessive friction losses, and sprinkler nozzles must be sized to apply the right amount of water within a given period.

In order to properly lay out a sprinkler system a designer must know the following :

(1) water holding capacity of the soil;
(2) soil filtration rates;
(3) type of crop to be grown;
(4) fuel or power source for pumping;
(5) availability of labour;
(6) physical features of the land to be covered by sprinklers.

Most sprinkler dealers have qualified personnel for doing an adequate design of sprinkler system. However, assistance in the evaluation of a design or existing layout is available from the Water Resources Division of the Alberta Department of Agriculture.



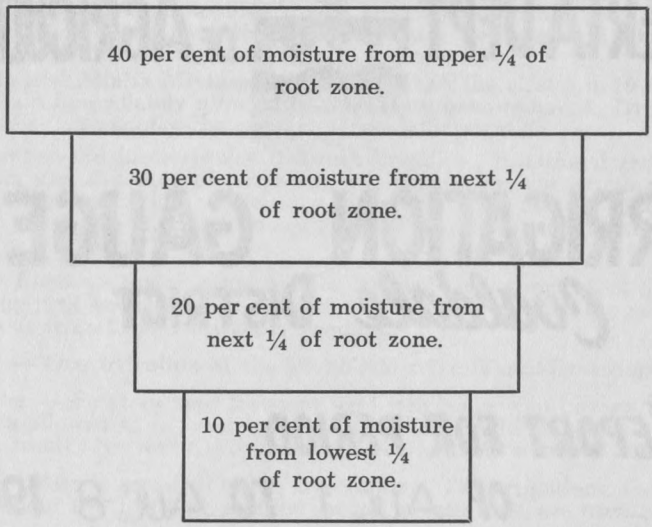
Sprinkler Irrigation.

Water Application

Water application should be made on each irrigation run by starting with a maximum of water that will not cause erosion. Then, after about three-quarters of the run is wetted (which should be one-quarter of the total time for irrigating the run), the flow is reduced to an amount that will disappear into the soil through the full length of the run. This reduces run-off to a minimum. Several syphon tubes, for example, can be used to begin with on each run, then reduced to only one or two at the same time that new runs are started.

Soil Moisture Relations

Root Zone — The root zone or area of soil that contains the plant roots is about two feet for shallow-rooted crops, four feet for most normal crop roots and as much as six feet for the root of alfalfa. The following table shows the relative use of moisture by plants from varying depths of soil. —



Plant Use of Moisture — Plant use of moisture for most crops is about 0.15 to 0.3 of an inch of water per day during the normal growing season. The greatest use is during the peak growth period and hottest days.

Readily Available Moisture — This is the moisture in the soil that is available for plants to use. It is about one inch for sand soils, two inches for loam soils, and 2½ inches for clay soils per foot of root zone depth. For example, a four-foot root zone of loam soil can be expected to hold approximately eight inches of readily available moisture. Following is a table showing the water-holding capacities of different textures of soil —

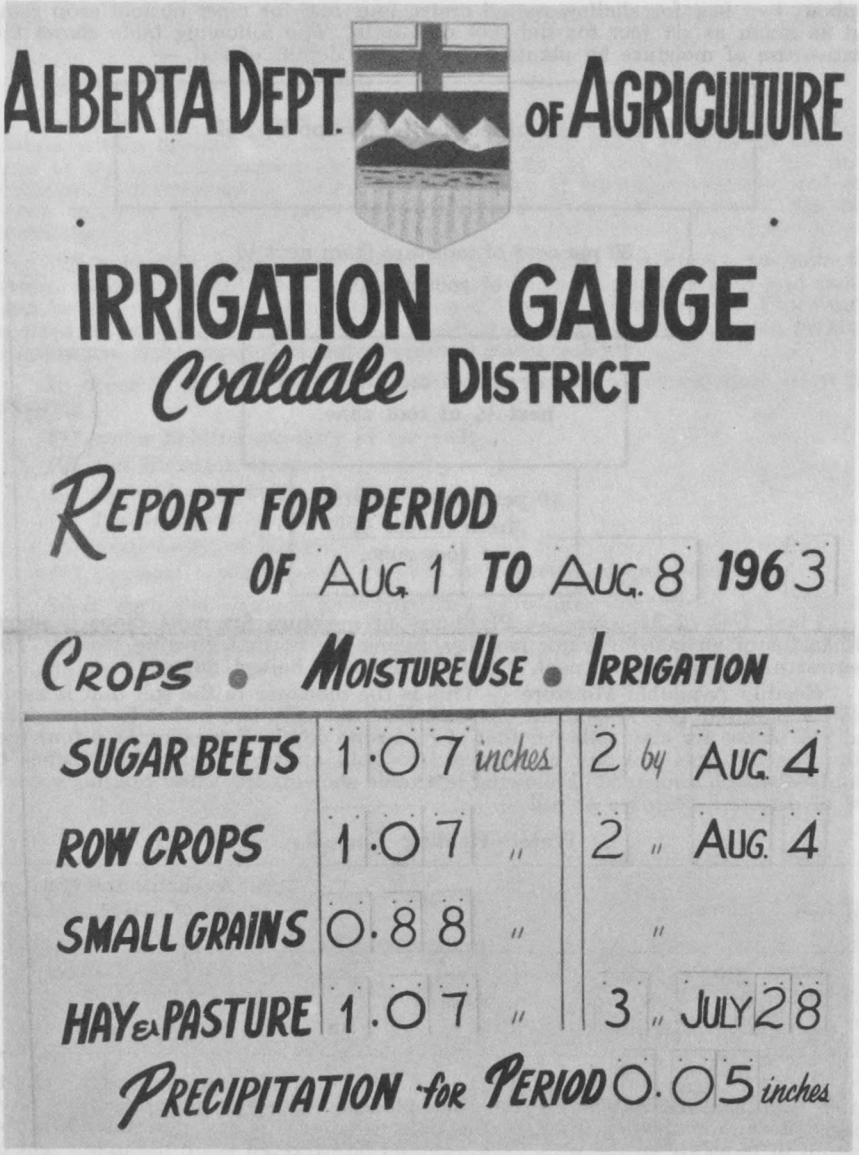
Water - Holding Capacity

Soil Texture	Total Available Soil Moisture (Inches of water held per foot of soil depth)
Coarse sand	0.50 - 0.75
Sandy loam	1.00 - 1.50
Silt loam	1.50 - 2.50
Clay or silty clay	2.00 - 3.00

Time to Irrigate — Never let the soil dry out to the point where the plants suffer from lack of water. By the time plants show signs of injury they have needed water for about a week, so the time to irrigate is best determined by the amount of moisture in the soil. Fields should be irrigated when the upper foot of soil contains about one-half of its available moisture. With a little experience, the irrigator can tell the amount of water needed by feeling the soil.

The following can be used as a guide for determining the need for irrigation for any except very sandy soils: Dig down about six inches to a foot, take a handful of soil and form a ball with firmhand pressure. The ball of soil is then tossed a foot into the air and allowed to drop on the palm of the hand.

If the ball does not crumble within five tosses, more than half of the available moisture is in the soil, and irrigation is not needed. If the ball crumbles during the tossing, between one-quarter and one-half of the available water is left in the soil and irrigation should be started. If the ball cannot be formed, the soil has been allowed to become too dry and irrigation should be started immediately.



Irrigation Gauge.

Fall irrigation of forage crops is recommended to lessen the danger of winter-killing. Fall irrigation of fields to be seeded the following spring ensures an adequate supply of moisture for germination. The need for irrigation in the spring is usually delayed until after seeding operations are completed.

The Alberta Department of Agriculture, Water Resources Division, Agro-hydrology Branch, supplies, on a subscription basis, actual water budget information. This information consists of records that tell the subscriber exactly what the moisture status of his fields are, and when to irrigate. The accompanying photo shows the "Irrigation Gauge" used for this purpose.

Irrigating Crops — See references. The amount of moisture in the soil determines the time to irrigate.

However, certain general recommendations can be made for specific crops, bearing in mind that weather conditions influence the need for irrigation. The following recommendations assume that a good irrigation has been given in the fall so that the soil has gone through the winter well supplied with moisture. All irrigations should fill the root zone to capacity.

Alfalfa and Alfalfa Mixtures — Irrigate when the alfalfa is 10 to 12 inches high and again immediately after each cutting has been removed. Irrigating after the last cutting constitutes the recommended fall irrigation.

Pastures — Pastures require frequent irrigation. Rotational grazing should be practiced, and the time of irrigation will depend on the length of time the stock are left on each field. Whenever the animals are moved, that portion of the pasture should be irrigated immediately. Pastures should be irrigated every two to three weeks.

Sugar Beets — Sugar beets require frequent irrigations started soon after thinning, applying enough water each time to connect up with the moist subsoil. Three or four irrigations are usually required.

Grain — One irrigation at the shot-blade stage is usually enough.

Potatoes — Potatoes need frequent light irrigations about every three weeks. If the soil is allowed to dry out between irrigations, reduced yields and lowered quality will result. No water should be applied for about a month before harvest.

Corn — Corn is sensitive to too much water. Two irrigations, the first when the corn is about two feet high and the second at tasselling, are usually sufficient.

Canning Peas — Canning peas should receive a good irrigation when about six to eight inches high and lighter application shortly before harvest.

Self Check on Irrigation Efficiency — An examination 48 hours after an irrigation of samples from each foot of soil to a depth of five or six feet will indicate whether enough water or too much water was applied. If the moisture in the soil is evenly distributed to the depth only of the root zone, then the irrigation is very efficient. If dry areas occur in the root zone, then the application was insufficient. If the soil is excessively wet below the root zone, then too much water was applied. Numerous checks with a soil auger should be made in each field. Corrections in irrigations, according to the findings of this checking system can then be made at the next irrigation.

IRRIGATED FARM MANAGEMENT

Irrigation farming involves a number of special management problems peculiar to this type of agriculture.

Higher per acre capital investment and operating costs exist as compared to dry land farming in the same area. Good irrigated farm land sells for a higher price than dry land in the same district. More machinery is required when compared with the same acreage of dry land. Additional labour is required to more intensively cultivate, irrigate, and harvest crops on irrigated farms and to handle the necessary complement of livestock.

A more complicated balance exists between soil, fertility, water, and plants when optimum quantities of water are applied to the soil. Special attention must be given to the management of the soil, including the use of soil-building crops, the use of manure and mineral fertilizers. It is also important to apply the right

quality of water to each kind of crop to obtain maximum yields. Good drainage of the soil becomes an important management problem. Lack of drainage can cause reduced yields, deterioration of land, and costly reclamation.

The necessity for higher gross and net returns per acre for smaller acreages farmed makes necessary the production of specialized crops. This is usually coupled with the growing of legumes and forage crops to maintain fertility, the growing of feed grains, and the feeding of livestock including dairy cattle. Where specialized crops cannot be marketed, the production of legumes, forage crops and cereal grains can most profitably be combined with one or more livestock enterprises. This is the most satisfactory way to ensure a readily available market for these crops. Intensively managed cultivated pastures are playing an increasingly important role in successful irrigation farming.

SOIL SALINITY AND DRAINAGE

Occurrence of Saline and Alkali Soils

When neither surface nor ground water drains away satisfactorily, concentration of the soluble salts near the soil surface results because of water evaporation. There are two distinct types of soil formed as a result of this accumulation — saline soils and alkali soils.

Saline soils are those that have accumulated sufficient soluble salts, principally calcium and magnesium salts, to have an adverse effect on crop production.

Alkali soils have a predominance of soluble sodium salts. The "blowout" or solonetz soils, which are examples of one type of alkali soils, are characterized by an uneven or pitted surface and an impermeable layer high in sodium (see section on Solonetz Soils).

Most Solonetz soils present problems under irrigation, and the costly reclamation measures necessary would likely make irrigation of such soils impractical. Although salt-affected soils occur widely in nature, the most serious situation in agriculture is encountered where previously productive soils are salinized.

Effect of Salts on Plants

The effects of the presence of excessive amounts of soluble salts on crop production are noted in poor stands, uneven growth, poor yields, and bare spots. Plant growth in these areas is retarded or prevented by the reduction of water uptake, or by some direct chemical or toxic effect. In addition, an alkali soil usually is in such poor physical condition that soil structure, permeability, and aeration are not favourable for growth. These effects are particularly critical when the plant is germinating. Therefore, it is difficult to establish a stand under such circumstances. Salt concentrations in the soil can be measured, and from these measurements it is possible to preduct or account for salinity effects on plant growth in the field. Then changes in crops planted or in cultural operations can be made if necessary.

Source of Salt Accumulation

Salts are present in the virgin soil, varying in concentration, in chemical composition, and in depth of occurrence with the soil type and with the rainfall pattern of the area. Water re-distributes the salts in ways varying with the soil type, topography, and other factors. Some salt is invariably present in irrigation water, and so salts are added to the soil. The major irrigation districts in Alberta are fortunate in having a source of good quality irrigation water, low in salt content, diverted from the mountain streams. Water from wells, minor streams and ponds may have a much higher salt content and should be tested for quality for irrigation in the laboratory before use.

Soil Salinity Changes With Irrigation

Surveys have shown that under favourable conditions, most of the salts originally present in many soils developed for irrigation to date in southern Alberta have been moved by the applied irrigation water to depths below the soil root zones. Salinity and water-logging problems have arisen mainly in certain areas where there are unfavourable conditions of inadequate drainage of surface

waters, and high ground water levels caused by over-irrigation and by seepage from canals, laterals, and head ditches. Evaporation of ground water is then increased with a corresponding increase in surface-soil salinity as the salts accumulate.

Emphasis on Measures to Prevent Soil Salinization

Most irrigated soils in Alberta have relatively tight subsoils which greatly restrict the ready movement of excess ground water. As a result, the removal of excess ground water through the soil by natural drainage is slow, and the removal by artificial sub-surface drainage is difficult and expensive.

Salinity problems and drainage requirements in irrigation can be minimized by :

(1) A careful selection of the lands to be irrigated, especially from the standpoint of soils and topography.

(2) The provision of drains for excess surface water.

(3) Lining canals, laterals, and head ditches where necessary to minimize seepage losses.

(4) A knowledge of crop water requirements and the amount of water that can be stored in the soil and made available to plants. The application of that knowledge in good irrigation practices will waste as little water as possible through the soil.

(5) Suitable irrigation layouts and land preparation including land levelling.

Improving Salty Lands

Soil analyses and observations of ground water levels and other field conditions are necessary to diagnose the problems that arise in salt-affected areas and to determine remedial measures. To improve salty lands, an excess of water must be applied to wash the salts down and out of the soil root zone. There is no chemical treatment that will neutralize the salts. However, on alkali soils, some amendments such as gypsum may be helpful in addition to the washing.

Usually it will be necessary to supplement the natural soil drainage with covered tile or open drains to remove the excess subsurface water and salt and transport them out of the area. Both types of drains have been shown to be effective. Many irrigated soils in Alberta have limitations with respect to both depth and permeability. For this reason, and also because of the cost, comparatively few installations of open or tile drains have been made in Alberta for sub-surface drainage. Only limited data are available on their performance. Experimental work on the depth and spacing of drains is being undertaken. Observations are being made on field installations.

Farming Salty Lands

Where it is not considered feasible to lower materially the soil salinity levels, any of the following practices may be helpful in keeping lands in production.

(1) The ploughing-down of farm manure, green manure, or crop residues.

(2) Planting so as to avoid salt build-up around the seed. The soil can be ridged and the seed planted near the base. The salt migrates to the top of the ridge leaving a zone of lower salt concentration, which makes conditions for germination more favourable near the base.

(3) More frequent light irrigations to keep plants supplied with readily available moisture.

(4) The selection of crops most tolerant to the salt condition during germination and growth.

Here are some of the common field crops grouped according to their tolerance to salts. These groupings have largely been made on the basis of tests in other coutnries. They are considered, however, to be generally valid for local conditions. Differences in the salt tolerance of plant species will be encountered.

High Tolerance

Tall wheat grass	Barley	Garden Beets
Slender wheat grass	Bird's-foot trefoil	Asparagus
Rape	Sugar Beets	Spinach

Moderate Tolerance

Crested wheat grass	Flax	Potatoes
Orchard Grass	Sunflower	Peas
Alfalfa	Reed Canary Grass	Tomatoes
Sweet Clover	Wheat, Rye, Oats	Sweet Corn
Brome Grass		

Low Tolerance

White Dutch Clover	Ladino Clover	Field Beans
Alsike Clover	Red Top	Strawberries
Red Clover	Timothy	Green Beans

Because of the complexity of salinity and drainage problems, the costs involved, and the need for a measurement program, farmers are urged to seek technical assistance. Inquiries should be directed to the irrigation district concerned or to the provincial or federal departments of agriculture.

REFERENCES

	Publication No.	Agdex No.
Canada Department of Agriculture		
Irrigation Water — Its Use and Application	1199	563
Growing Irrigated Crops in Southern Alberta....	1152	135/70-1
Alberta Department of Agriculture		
Irrigation in Alberta — #156	560	560

CULTURAL PRACTICES AND CROP SEQUENCE

THE BROWN SOIL ZONE

Low annual precipitation and high seasonal evaporation characterize much of the brown soil zone. Farming here must make the best possible use of the available soil moisture. Only the better soil types should be considered arable. Most of the arable soils lie in the western half of the zone where rainfall is between 13 and 14 inches annually. Even on the good soils, the farm unit should be larger than in most other parts of the province and be handled as efficiently as possible.

Choice of dry land crops is limited. The major cultivated crop is spring wheat. Most farmers have adopted a wheat-fallow rotation. Some barley, flax or mustard seed may be grown in place of wheat, but farmers should ensure that enough stubble remains to protect the soil from drifting during the fallow year. (See Soil Drifting, page 16.)

Flax is a poor weed competitor and should be seeded only on clean land. Mustard should be grown preferably under contract with a reputable seed firm. On sandy soils and light loam soils, fall rye is a suitable grain crop. Near the western boundaries of the brown soil zone, when stubble land has a depth of over 27 inches of moist soil at seeding time, some stubble may be recropped rather than fallowed.

Little grass has been grown to date on cultivated land in the brown zone. However, considerable permanency, through maintenance of fertility, may be attained. Grass should be grown for a four to five-year period during each 12 to 15-year cycle. In most parts of this zone, crested wheatgrass, seeded into clean stubble and used for hay or pasture, has been most satisfactory. In the northern section of the brown soil zone, brome grass, alfalfa, and crested wheatgrass have been grown successfully for seed production. Mixtures of brome and alfalfa and crested wheatgrass and alfalfa have been grown for forage.

Early cultivation of fallow with a combination of well-adjusted disc- and sub-surface-type tillage implements provides for the best weed control and moisture conservation and protects against soil drifting. A properly-adjusted one-way disc, a blade cultivator, and a rod weeder have proved useful for normal fallow operations.

Wherever possible, at least some livestock should be kept to consume non-arable grassland, cultivated grasses from rotations and sparse crop growth during drought years. These practices lend a measure of stability and permanency.

THE DARK BROWN SOIL ZONE

The soil and climatic conditions in the dark brown soil zone permit a somewhat wider variety of crops and cropping practices than in the brown soil zone. Along the border of these two zones the system of farming most likely to succeed is similar to that used in the better parts of the brown soil zone.

This is primarily a wheat-producing area. Every effort must be made to maintain its productivity at a high level through proper cropping practices.

Although a rotation of wheat-wheat-fallow is most commonly used in this zone, it is possible in some years to "stubble-in" wheat for two or even three years. However, sub-soil moisture at seeding must be greater than 27 inches deep. Continuous cropping to wheat has not been economically practical. This is because in years with below normal rainfall little or no crop is obtained. Soil drifting also becomes serious because of lack of sufficient trash cover. Barley and oats may replace wheat in most areas. They often serve as a second or third crop after fallow. Flax produces good yields in the central and southern parts of this zone. However, to avoid disease infestation, it should not be grown two years in succession on the same land.

Durum wheats of good quality may be grown in the south end of the zone. In the area south and west of Iron Springs, winter wheat may replace spring wheat in most rotations. Commercial mustard, best grown under contract, does well in the southern part of the zone. Sunflowers, also best grown under contract, are usually late-maturing. Despite this, they have produced satisfactory yields under careful cultural practices.

Cover crops of wheat, oats or barley, seeded during July, provide needed protection to fallow on soils likely to drift in the central part of the dark brown soil zone.

It is desirable, both from the standpoint of economics and soil management, to seed fields down to grass or grass-legume mixture for a four to five-year period every eight to 10 years. Including sweet clover in the grain crop for green manuring the following year appears to be beneficial where annual precipitation exceeds 16 inches. The inclusion of livestock and forage crops tends to add stability to farms in this zone.

THE BLACK SOIL ZONE

The black soils permit use of more intensive cropping systems than the brown, dark brown and thin black soils because of better moisture conditions. Summerfallow is costly and not recommended except for control of persistent weeds. (See section on "Weed Control", page 50.)

Soils in this zone are best used for mixed farming involving grain and forage crops rather than straight grain. No one rotation will be suitable for all farms because many factors affect the selection. This includes livestock program, topography on the farm, field size, capital, markets, and so on. The district agriculturist can be of great assistance in evaluating these factors. A handy rule is that no field should be more than four or five years away from forage.

In view of the variety of rotations that can be successfully used, the reader is referred to the publication on suggested rotations listed at the end of this section. It is emphasized that fertilizer will likely be required. Barley and oats are the best grain crops while grass-legume mixtures give the greatest forage yields. A "partial" summerfallow in the year of breaking sod is usually employed.

The value of grass-legume mixtures for improvement of soil tilth, control of erosion and suppression of weeds has been amply demonstrated.

The thin black soils are located between the black and dark brown. Moisture is much more limiting than in the black zone. Grain production, chiefly wheat, predominates. Summerfallow is used extensively both for weed control and moisture conservation. However, a grain-fallow rotation with periodic seeding down to forage is a more practical type of cropping system for this area.

THE GREY WOODED SOIL ZONE

Forages are even more essential for the productivity of grey wooded soils than for the black soils. But the principles determining the type of rotation are the same. A six-year rotation with three years of grain and three years of forage has proved popular. A short rotation involving legume ploughed down as green manure may be used to more quickly improve soil that had not previously been sown to legumes. After several rounds of this rotation, a longer, more permanent one could be established. A handy rule is that no field should be more than two to four years away from forage.

A number of grey wooded soils of West-Central and North-Central Alberta are sulphur deficient. On these, sulphur-bearing fertilizers for legumes are necessary to obtain the full benefit of the legume crop. Results from plots at Breton for the period 1930-61 clearly show this effect.

Fertilizer	Wheat after fallow	Wheat after clovers
None	14.9 bu.	13.1 bu.
Sulphur (21-0-0)	20.0 bu.	30.0 bu.

This yield was due primarily to nitrogen rather than sulphur.

The wheat yielded less after clovers than after fallow when no sulphur was applied. When sulphur was applied, the wheat after clovers yielded 10.0 bushels per acre more than wheat after fallow. For more details on sulphur and other fertilizers on these soils see page 18 on Soils, Zonation and Fertility. (See references.)

IRRIGATED SOILS

Irrigation farmers have ample opportunity to use well-planned rotations because of the wide choice of crops that can be grown and the assurance of an adequate supply of moisture. The choice of crops is entirely up to the farmer.

Perhaps, however, it is limited in some cases by the availability of contracts for certain of the specialty crops. Summerfallow has no place in irrigated agriculture except when a very serious weed problem or land-levelling program may justify its use.

The livestock farmer should grow forage crops in his rotations. Livestock provides an outlet for such unmarketable products as beet tops, corn stovers and pea vines. It also supplies manure which is by far the best fertilizer. Manure should be applied to the fields in early fall and plowed under. This will enable it to decompose as completely as possible before the following crop is sown. The most remunerative crops, such as sugar beets, should follow on the manured fields. Farmers who do not keep livestock should plan to grow a legume crop for plowing under as green manure.

It is well to plan the fertilizer program in such a manner that the greatest net returns per acre can be expected from year to year. For example, sugar beets should be grown on manured fields as this crop responds well to the application of barnyard manure. Commercial fertilizers should also be aplied with sugar beets and canning crops as these will usually give the greatest returns. If cereal crops follow, they will benefit from the residual manure and fertilizer that are in the soil and may not require additional fertilization. (See Fertilizers, page 21.)

The three rotations outlined are types that may be followed in the irrigation areas.

1. **Very intensive farming:** Sugar beets, canning crops and forage crops.
   (1) Canning peas — manure stubble and plow under in the fall.
   (2) Sugar beets
   (3) Canning corn
   (4) Soft spring wheat as companion crop for alfalfa or alfalfa-brome mixture.
   (5) Hay one
   (6) Hay two
   (7) Hay three
   (8) Potatoes

2. **Cash crops without forage.**
   (1) Canning peas
   (2) Potatoes
   (3) Sugar beets
   (4) Grain and sweet clover
   (5) Plow sweet clover for green manure about May 20 and plant canning corn. (If manure available, plow under with pea stubble.)

3. **Irrigated pasture with limited contract crops.**
   (1) Grain
   (2) Pasture seeded in stubble
   (3) Pasture
   (4) Pasture
   (5) Pasture
   (6) Pasture — break in fall
   (7) Grain — manure stubble and plow under in fall
   (8) Row crop or specialty seed crop.

TILLAGE

About two-thirds of all power in farm draft is used in tillage.

The principal objectives in tillage are :

(1) To control weeds and conserve moisture.
(2) To improve soil tilth.
(3) To develop a desirable soil structure for a seed or root bed.
(4) To control insects, plant diseases and erosion.
(5) To prepare land for irrigation.
(6) To incorporate crop residues, fertilizers or soil amendments into the soil.

Some of these objectives conflict and compromises are often necessary in individual situations.

For best results, timeliness, suitable implements, proper adjustment and operation are important. Lack of attention to these requirements can result in wasted effort and actual damage.

There are many types of tillage implements. One selected for any particular operation should depend upon field characteristics, vegetation, weather conditions, topography and other factors. (See section on Tillage Machinery, page 193.)

Summerfallow is designed to control weeds and conserve moisture for the following crop. Therefore, begin cultivation early in the spring and keep weed growth to a minimum.

Use a combination of implements and methods that will result in the maximum amount of stubble and trash remaining on the surface of the soil at the next seeding.

A light stubble requires more care to preserve it. Sub-surface implements such as rod and blade weeders should be used. For heavy stubble, discers and one-way discs may be used for the first operations.

Cultivation generally should be on the shallow side. Deeper than three to four inches is seldom justified. This depth is usually required to provide adequate weed control.

Fall cultivation of stubble is used to control perennial weeds, germinate annuals, control insects or to reduce an excessively heavy trash cover. It is recommended that the stubble remain standing after cultivation to trap winter snow.

SEEDING

Various types of equipment are available for seeding. (See section "Seeding and Planting Equipment" page 194.)

In the brown soil areas and wherever a heavy trash cover is essential, the high-trash clearance hoe drill can be very useful. This implement, with its wide spacings, permits seeding into heavy trash cover without clogging.

Dates of seeding vary considerably within the province depending upon location and season. Consult your nearest district agriculturist or experimental farm.

Wheat and other late maturing crops such as mustard must be sown fairly early. Coarse grains require a shorter growing period. Therefore, oats and barley can be sown later which permits pre-seeding tillage. This is a distinct advantage in the control of weeds.

As flax requires a long growing season, it should be seeded fairly early. However, since flax is subject to severe damage by spring frosts, seeding should be delayed sufficiently to avoid freezing of the flax seedlings. In Central Alberta flax seeding is usually finished about May 15 — seldom later than May 20 — for best results.

Rates of seeding will usually be heavier where moisture is more abundant and seeding will be lighter in the drier soil areas. In tests at Lacombe Experimental Farm, slight reductions in the rate of seeding did not give corresponding reductions in yield. This would indicate that lighter seeding should be considered wherever possible. However, a heavier rate of seeding provides more competition to weeds and is therefore recommended where weed control is a problem.

Ranges in seeding rates are as follows:

Crop	Bu. per acre
Wheat	¾ - 2
Oats	1½ - 3
Barley	1½ - 2½
Rye	¾ - 1½
Durum	1¾ - 2¼
Crop	**Pounds per acre**
Rape	6 - 8
Flax	30 - 40
Mustard	3 - 5

Depth of seeding should be kept to a minimum. Sow deep enough to place the seed in moist soil and no more. The use of a packer or press drill will assist in bringing moisture closer to the surface, permitting shallower seeding. The best depth for cereal grains is one to two inches. Never seed deeper than three inches as reduced yields usually result. Mustard and rapeseed should be sown from ½ to 1½ inches deep. Forage seeds should be planted no more than a ½-inch deep for the smallest seeds and 1½ inches for the largest seeds.

USE GOOD SEED

Only by using good seed of a suitable variety can a farmer produce most profitably. Petigreed, high grade seed means varietal purity and uniform results in the field. It also means high germination and freedom from weeds and disease. Low grade seed means reduced yield and quality.

If using your own seed, select the best and obtain a germination test. A representative one pound sample taken to your elevator agent will be sent to a recognized laboratory for testing.

Cleaning is important. This can best be done by a reputable seed cleaning plant. Alberta is well served with good cleaning plants, having some 55 municipal and numerous privately owned plants throughout the province. In addition to cleaning, the seed should be treated with a recognized seed protectant. The job of testing, cleaning, and treating seed should not be left until spring. It should be done early in the winter when facilities are more readily available.

HARVESTING

Different crops require different methods. The combine has largely replaced the binder-thresher method because of the saving in time and labour. The crop can be straight combined or picked up from a swath. Swathing permits earlier threshing, thereby reducing risk from weather and insects and eliminating green weeds in threshing. (See section "Agricultural Engineering". page 193.)

CEREAL CROPS

Swathing should be started when the grain has a moisture content of 35 to 40 per cent (when the kernel can be dented easily with the thumb nail). The crop should be combined as soon as the grain has dried sufficiently.

The highest moisture content allowed for straight grades and storage is:

Wheat 14.5 per cent; durum wheat 14.5 per cent; oats 14 per cent; barley 14.8 per cent; rye 14 per cent; flax 10.5 per cent; rapeseed 10.5 per cent, and mustard 11 per cent.

Malting barley should be in the firm dough stage before swathing and it should be combined as soon as possible. Special attention must be given to combine adjustments. (See section on harvesting machinery, page 195.)

FORAGE AND SPECIALTY CROPS

In harvesting special crops such as grass and legume seed, rape and flax, special attachments and adjustments to the implements will be required. Information on harvesting these crops can be obtained from District Agriculturists or Experimental Farms in your district. (See also section on Forage Crops, page 70.)

REFERENCES

	Bulletin No.	Agdex No.
Grey Wooded Soils and Their Management	21	512/1

WEED CONTROL

Weeds cause the farmer greater losses than any other production hazard. The average loss due to weeds in cereal crops is estimated to be $5 per acre. Successful crop production in Alberta depends on moisture conservation. Since this can only be accomplished by good weed control practices, weeds further increase production costs. Weeds, especially persistent perennial species, decrease land values.

CLASSIFICATION BY GROWING HABITS

Annuals — grow from seed in the spring or summer, produce seed and die in the same season. (e.g., wild oats, hemp nettle, Lambs-quarters.)

Winter Annuals — begin growth in the fall, live over winter and produce seed the following year. Stinkweed and some others may grow as either annuals or winter annuals.

Biennials — require two seasons to produce seed. They begin growth in the first year, start from their roots in the following spring, produce seed and die (e.g., goatsbeard).

Perennials — live for more than two years, and reproduce from seeds or roots, or both. The roots are dormant over winter and start new top growth every spring (e.g., Canada thistle, couchgrass, leafy spurge).

GENERAL RECOMMENDATIONS FOR THE CONTROL OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS

These weeds can be controlled best by reducing the number of seeds in the soil. Proper tillage, sound planting practices, herbicide use and planned cropping systems will do much to prevent their seeding and re-infesting the soil.

Tillage and Seeding

Till before seeding to destroy as many weeds as possible and till only deep enough to kill existing weed growth. Deep tillage at this time is detrimental to the establishment of vigorous crop seedlings which will compete successfully with weeds.

Sow only sound, well-cleaned seed, and place it in firm, moist soil. Seeding with a press drill, or packing, harrowing or rod weeding right after seeding, will hasten germination.

Recommended fertilizers often reduce weed competition by stimulating crop growth. On land heavily infested with weed seeds, sowing 25 per cent more grain will reduce weed competition.

In seasons when weeds have emerged before the crop has sprouts more than one-half inch long, shallow rod weeding or harrowing after seeding will give good weed control.

Herbicides

(See section on Chemical Weed Control.)

Summerfallow Practices

(a) Fall tillage is recommended only where there are heavy infestations of winter annuals and biennials resistant to 2,4-D. Some annuals such as wild oats germinate more readily in the spring if lightly tilled late in the fall.

(b) Tillage of fallow in the spring should begin as soon as weed growth warrants, but it should have regard for the control of wind and water erosion. (See Soils section.)

(c) Partial fallow, after a crop of hay has been removed, can help to control such weeds as couchgrass and Canada thistle.

Competitive Crops

(a) Barley and rye compete strongly with weeds. Flax is a poor competitor.

(b) The inclusion of forage crops in the crop rotation will help in the fight against weeds.

GENERAL RECOMMENDATIONS FOR THE CONTROL OF PERENNIAL WEEDS

Seedling perennial weeds are controlled like annuals. However, once established, the root system as well as the top growth must be destroyed.

The root system of a perennial plant serves both as a means of spreading and as storage for food. A piece of rootstock containing a bud is capable of initiating a new plant. Extreme care should be taken to prevent spreading root pieces with tillage machinery.

The roots store the food manufactured by the leaves. The food in the roots is partially used for the new growth from the root buds. If this leaf growth is restricted by repeated or intensive tillage, the roots will eventually die of starvation. Intensive tillage of fallow means tillage operations done often enough to prevent the appearance of green regrowth for more than four to six days.

Intensive tillage tends to destroy the trash cover rather rapidly and to pulverize the soil. Strip cropping, and the use of implements that ridge the soil or do not undully cut up and bury the trash, help to prevent erosion. Herbicides may be used as a substitute for part of the tillage in the control of some perennials.

PRECAUTIONS

(1) Prevent the spread of weed seeds in the movement of farm machinery, livestock, grain, hay, screenings and soil.

(2) Watch for unfamiliar weeds. Specimens, preferably in flower and including part of the root, should be sent for identification to your district agriculturist or the Field Crops Clinic of the Alberta Department of Agriculture, Edmonton.

(3) Community effort is essential to successful weed control. Support your weed inspector or agricultural fieldman in his job of controlling weeds.

CHEMICAL WEED CONTROL

Control of Weeds in Field Crops

Early treatment of grain crops with selective herbicides as outlined in the table, under specified conditions, will kill susceptible weeds. The removal of these weeds will usually result in increased crop yields. Young weed seedlings in the two to four-leaf stage are easier to kill than older weeds with the recommended rates of chemical. A vigorous stand of crop will usually result in more effective control of weeds treated with a given rate of herbicide.

There are a number of herbicides which can be used for broadleaf weed control in grain crops. Examples are 2,4-D, MCPA, 2,4-DB, MCPB, dicamba, bromoxynil, mecoprop, and dichlorprop. A farmer should select the herbicide which will control effectively and economically the widest range of weed species on his field.

All rates of chemical application are expressed as acid equivalent or active ingredient per acre unless otherwise stated.

Spring Wheat and Barley

The ester of 2,4-D is the most extensively used herbicide in Alberta for the control of weeds in these crops. Wheat and barley may be treated safely as soon as the fourth leaf appears or when the plants are about six inches high under normal growing conditions. Treatment can be made safely until the early boot stage or shot blade and again from the soft dough stage to maturity. If weed spraying is necessary before the four-leaf stage, MCPA or 2,4-D amine should be used.

If the predominant weeds are buckwheats, smartweeds, and others which are resistant to 2,4-D, then dicamba, bromoxynil or dichlorprop or mixtures containing these may be used. Dicamba should be applied from the two to four-leaf stage of grain. Barley is more sensitive to dicamba than are wheat and oats. The rate of dicamba should not exceed two ounces for wheat and 1.5 ounces per acre for barley. Bromoxynil may be applied from the two-leaf until the early boot stage. Safe stages on wheat and barley for dichlorprop are the same as for 2,4-D.

Mecoprop can be safely applied to wheat, barley and oats from the one-leaf to the early boot stages of growth at 16 to 24 ounces per acre of the active chemical.

Oats

Oats are tolerant to MCPA at all stages of growth except from the early boot to the soft dough stage. This chemical may therefore be applied as soon as weed conditions warrant.

Oats are sensitive to 2,4-D ester and are often damaged by its use. If 2,4-D is used to control weeds resistant to MCPA, use the amine formulation. With 2,4-D amine, treatment should be made between emergence and the two-leaf stage or between the six-leaf stage and early boot stage.

Dicamba, bromoxynil or mixtures containing these may be used on oats for the control of 2,4-D tolerant weeds such as the buckwheats and smartweeds. Dichlorprop is not recommended for use on oats.

Winter Wheat and Fall Rye

These crops should be treated in the early spring with 2,4-D or MCPA with the choice of chemical and rate depending upon the species of weeds present. Treatment is not recommended during the fall or in the late spring, after the crop has reached the early boot stage of growth.

Flax

Flax may be treated with 2,4-D or MCPA as soon as the plants are two inches high, but before there is any sign of bud formation. For maximum safety, this crop should be treated early, as soon as there is enough emergence of susceptible weeds to make it practical.

Flax is more tolerant to MCPA than to 2,4-D. MCPA should therefore be used except for the control of more resistant weeds such as Russian thistle. In such cases 2,4-D ester should be used at the recommended rate in 10 - 15 gallons of water. Some delay in maturity and damage to flax may occur when 2,4-D ester is used.

As an emergency treatment for the suppression of wild buckwheat, smartweed and cow cockle, dicamba may be used at two ounces alone or 1.5 ounces when mixed with 2,4-D. Delay in maturity and crop injury should be expected.

The sodium salt of TCA at four to six pounds per acre or dalapon at ¾ to 1½ pounds per acre may be used to control green foxtail (wild millet). These herbicides may be applied anytime from emergence of the weed until it is two inches tall. Safest growth stage for the flax is when it is four to six inches in height. Spray volume should be 10 - 15 gallons per acre and overlapping of spray swaths should be avoided to minimize risk of crop injury. Dalapon or TCA may be mixed with MCPA, 2,4-D or MCPB for combined control of green foxtail and broad-leaved weeds.

Rates of Chemicals for Crops

The table shows the quantity of active ingredient to use per acre. With the exception of butyric formulations, all should be applied in about four gallons of water per acre. The 2,4-DB and MCPB should be applied in 15 - 20 gallons of water.

Where there is a range in rates shown in the table, the rate to use would be influenced by (1) stage of weed growth, (2) kind of weed, and (3) growing conditions. Annual and biennial plants are most susceptible when young. Perennials are generally less susceptible than annual weeds with best results being obtained if the chemical is applied at the early bud stage. Weeds are more susceptible to 2,4-D and MCPA under conditions of rapid growth.

The higher rates in the range are recommended during advanced growth stages of weeds, under drier conditions, and when crops are heavily infested with weeds.

SPRAY FORAGE CROPS

Alfalfa, Alsike, Red and White Clovers

New seedings of these crops are most resistant to MCPA, 2,4-D, MCPB and 2,4-DB from the first to the third trifoliate leaf stage. They should not be

Ounces per acre of herbicide (active ingredient) required to control certain common annual, winter annual and perennial weeds in wheat, oats, barley and rye crop not underseeded with legumes.

(Rates[1] of 2,4-D or MCPA over 8 ounces per acre or dicamba over 1.5 ounces per acre may injure grain crops.)

Weeds[3]	2,4-D amine	2,4-D ester	MCPA	2,4-DB[2] ester	MCPB[2] salt	Dicamba (e.g. Banvel D)	Dicamba 2,4-D MCPP (e.g. Banvel 3)	Bromoxynil (e.g. Brominil)	Bromoxynil + MCPA (e.g. Buctril M)	Mecoprop (e.g. Compitox)
Annuals, winter annuals, biennials										
Blue bur	8	6-8	8-12	R[4]	R	—[5]	—	—	—	—
Buckwheat, tartary	8-12	8	8-12	24	—	3-4	8	6	8	16-20
Buckwheat, wild	R	8-12	R	16-24	32	2-3	6-8	4-6	8	R
Chickweed, common	R	R	R	R	R	—	—	R	R	16-24
Cockle, cow	R	R	R	R	R	2-4	8	R	—	16-24
Corn spurry	R	R	R	R	R	2-4	8	R	R	—
Flixweed	6-8	6-8	6-8	20-24	32	—	8	—	—	—
Lambsquarters	4-6	4-6	4-6	16	16-24	3-4	4-6	4-6	6-8	20
Mayweed, scentless	R	R	R	—	—	R	R	—	—	20-24
Mustard, ball	4-6	4-6	4-6	16-24	16-24	—	6	6	8	—
Mustard, hare's ear	4-6	4-6	4-6	—	—	—	—	—	—	—
Mustard, wild	4	3	4-6	16	16	R	4	6	8	—
Mustard, tumbling	4-6	4-6	4-6	16	20-24	—	—	—	—	—
Mustard, wormseed	4-6	4-6	4-6	16	16	R	4-6	6	8	—
Nettle, hemp	R	R	8-12	R	16-24	R	R	R	R	—
Pigweed, red root	12	8-12	12	20-24	20-24	4	6-8	6-8	8	—
Pigweed, Russian	6-8	6-8	6-8	16	20-24	—	6	—	—	—
Smartweed, green and pale	12	8-12	12	R	R	2-4	6-8	4-6	8	—
Stinkweed	4-6	4-6	4-6	12-16	12-16	R	4-6	6	8	—
Thistle, Russian	8-12	6-8	R	20-24	R	4	6-8	—	—	—
Perennial Weeds (Top growth control in grain)										
Bindweed, field	8-12	8-12	8-12	32	32	2	—	—	—	—
Cress, Hoary	6-8	6-8	6-8	—	—	—	—	—	—	—
Horsetail, field	6-8	6-8	5-7	—	—	R	—	—	—	16-24
Sow Thistle, perennial	8-12	8-12	8-12	32	32	2-4	—	—	—	24
Spurge, leafy	8-12	8-12	8-12	32	32	—	—	—	—	—
Thistle, Canada	8-12	8-12	8-12	32	32	2-4	—	—	—	R
Toadflax, yellow	R	R	R	—	—	—	—	—	—	—

1 : rates given are for sprays. If dusts are used, use 1½ times as much.
2 : 2,4-DB and MCPB may be applied on grain crops underseeded with legumes.
3 : for other weeds, see publication 641-1.
4 : R — resistant.
5 : — — indicates no information available.

(Mention of a trade name does not necessarily constitute a recommendation.)

sprayed after reaching four inches in height. Relatively large volumes of water for applying the spray treatments will reduce the risk of injury, although some "curl-down" is likely to be evident for a week or so after spraying. The amine form of MCPA at three to five ounces per acre in 10 to 15 gallons per acre of water will control many of our common annual weeds. Alfalfa is slightly more sensitive to this treatment than alsike, red and white clover. The butyric compounds, MCPB for the clovers and 2,4-DB for alfalfa at 16 - 20 ounces per acre in 20 gallons per acre of water will usually result in somewhat better weed control and less risk of injury to the legumes, but these chemicals are considerably higher in cost.

Newly seeded legume crops should only be treated if the stand is vigorous and dense and weeds present a serious threat to their further development. If a mixture of several legumes is used the choice of herbicide and rate of application will be governed by the most sensitive species.

Established stands of alfalfa may be sprayed with 2,4-D or MCPA at eight to 16 ounces per acre before growth begins in the spring to kill winter annual and biennial weeds. Narrow-leaved hawksbeard may be treated with 2,4-DB at 16 to 20 ounces per acre in 15 gallons per acre of water after alfalfa has stopped growing in the fall. The cost of this treatment is high. Established perennial grasses cannot be selectively controlled in legume stands with herbicides.

Wild oats can be controlled with diallate (Avadex) at 1.5 pounds per acre prior to planting or emergence or with barban at five ounces per acre after the crop and wild oats have emerged.

Green foxtail may be controlled by the use of TCA at two pounds per acre or dalapon at .75 pounds per acre in legumes seeded alone or with a companion crop of flax, barley or oats.

Crops treated with diallate, barban, TCA or dalapon should not be fed in the year of treatment.

Sweet Clover

This crop is highly sensitive to 2,4-D, MCPA, 2,4-DB and MCPB at any stage of growth. Even the spray drift from these herbicides can result in serious injury, especially during the flowering stage. The amine forms of MCPA at three to four ounces per acre in 10 to 15 gallons per acre of water may be used as an emergency treatment. Its use comes if a uniform stand of sweet clover seedlings are likely to be crowded out by susceptible annual weeds. Wild oats and green foxtail can be controlled with the chemicals given for alfalfa.

Grasses

New seedings of brome, crested wheat, creeping red fescue and Kentucky blue grass may be sprayed with MCPA or 2,4-D amine at rates up to eight ounces per acre. Spraying must be done during the three-leaf to the early boot stage to avoid injury to the grass.

Established stands may be sprayed with 2,4-D or MCPA at rates up to 16 ounces per acre, provided the spray is applied before the early boot stage.

Wild oats may be controlled with barban at the rates and stages given for alfalfa.

Sweet clover, alsike and red clover often occur as weeds in established grass stands intended for seed production. Esters of 2,4-D at eight ounces per acre will control sweet clover while 16 ounces per acre are required to control alsike and red clovers. These treatments will result in very little kill of the grasses. But if applied just prior to the early boot stage of the grass, they will give satisfactory control.

The above treatment applied just as the first dandelions come into flower will result in good control of this weed.

SPECIAL CROPS

The following table will serve to guide the growers of certain "specialty" crops in methods and materials available for the control of annual weeds.

PP = pre-planting, incorporated treatment — applied to soil surface shortly before crop seeding and thoroughly incorporated to a depth of two to three inches.

PE = pre-emergence treatment — applied immediately after crop seeding to a weed-free soil surface. Good moisture conditions essential.

Post = post-emergence treatment — applied at growth stage of weed and/or crop given in label directions.

No = control not feasible because of excessive crop injury or because herbicide not effective.

Yes = fair to good control possible.

Crop	Treatment and Rate*/Acre		To Control		
			Wild oats	Annual grasses	Broad-leaf
Beans (Snap or Dry)	PP	EPTC, 3 - 4 lb.	Yes	Yes	No
	PE	dinoseb, 3 - 4½ lb.	No	Yes	Yes
Carrots	PE	linuron, 1 - 2 lb.	No	Yes	Yes
	PE	prometryne, 1 - 2 lb.	No	Yes	Yes
	Post	linuron, 1 - 2 lb.	No	Yes	Yes
	Post	solan, 4 lb.	No	Yes	Yes
	Post	weed oil (Stoddard solvent type), 60 - 80 gal.	No	No	Yes
Corn (Field or Sweet)	PP	diallate, 1½ lb.	Yes	Yes	No
	PE	atrazine, 1½ - 2 lb.	No	Yes	Yes
	PE	dinoseb, 3 - 4½ lb.	No	Yes	Yes
	PE	linuron, 1½ lb.	No	No	Yes
	Post	2,4-D or MCPA amines, 4 - 8 oz.	No	No	Yes
Peas (Processing)	PP	triallate, 1½ lb.	Yes	Yes	No
	Post	barban, 5 oz.	Yes	No	No
	Post	dinoseb, ¾ - 1¼ lb.	No	No	Yes
	Post	MCPA sodium or potassium salts, 4 - 6 oz.	No	No	Yes
	Post	MCPA amine, 3 - 4 oz.	No	No	Yes
	Post	MCPB or 15 : 1 mixture MCPB : MCPA, 16 - 20 oz.	No	No	Yes (Also perennial thistle)
Potatoes	PP	diallate, 1½ - 2 lb.	Yes	Yes	No
	PP	EPTC, 3 - 4 lb.	Yes	Yes	Yes
	PE	dinoseb, 3 - 4½ lb.	No	Yes	Yes
	PE	linuron, 1 - 2 lb.	No	Yes	Yes
Sugar Beets	PP	diallate, 1½ - 2 lb.	Yes	Yes	No
	PP	PEBC, 4 lb.	Yes	Yes	Yes
	PP	pyrazon, 4 lb.	No	No	Yes
	PP	2 : 1 PEBC-diallate mixture, 5 - 6 lb.	Yes	Yes	Yes
	PP	2 : 1 pyrazon-diallate mixture, 6 lb.	Yes	Yes	Yes
	Post	barban, 6 - 8 oz.	Yes	No	No

*Herbicides may be applied to row crops as band treatments if necessary equipment is available.

Lawns

Established lawns may be sprayed whenever weeds show vigorous growth. Couchgrass control in established lawns has been achieved under experimental conditions but is still impractical for general use, particularly where desirable

trees or shrubs are present. To control dandelions and most other broad-leaved weeds in established lawns use 2,4-D amine, or mixtures containing mecoprop or dicamba, at 16 ounces per acre. The latter components are particularly useful where chickweed or white clover is to be eradicated. If mecoprop is used alone, the dosage should be increased to 24 ounces per acre for these two species. (One fluid ounce per 1,500 square feet of a formulation containing 64 ounces per gallon acid equivalent amounts to approximately 16 ounces per acre.)

Susceptible weeds in new lawns may be sprayed at about one-half the above rates with mixtures containing any or all of 2,4-D, mecoprop and dicamba once the grass plants have developed three leaves or after the grass has been cut twice.

Care must be taken to prevent spray drift from reaching susceptible plants. Use a watering can or a knapsack sprayer at low pressure to provide a coarse spray.

Pasture and Range

Selective chemicals may be used for weed and brush control on native grass pastures, waste land or cultivated pastures that do not contain legumes. Treatment with 2,4-D ester at one to two pounds per acre is recommended. For rosebush use a mixture of 2,4-D and 2,4,5-T. More than one application may be necessary. (See also Control of Woody Plants.)

Uncultivated Lands, Fencelines and Barnyards

Soil sterilants may be used to remove all growth, to prevent the spread of a troublesome weed, or to create a clean area for implement storage. Such chemicals as chlorate and borate-chlorate compounds at three to four pounds of product, or atrazine or monuron at two to three ounces per 100 square feet will effectively denude small areas of vegetation. These compounds should not be used near trees, nor should they be allowed to seep into water intended for domestic or irrigation uses.

CONTROL OF SPECIFIC WEEDS — ANNUALS

Wild Oats

Cultural methods afford efficient and effective control but are very dependent on the weather and the use of early maturing crops. These limitations can be largely overcome by the use of one of the recently developed herbicides.

Delayed seeding is the best cultural method for controlling wild oats. The surface should be tilled to a depth of not more than four inches early in the spring to promote germination. Seeding should be delayed until after maximum emergence of wild oats has occurred.

In most localities, seeding can be delayed until the first week in June if necessary. Pre-seeding tillage to kill wild oats is best done in dry, hot weather. It should not go below four inches, otherwise fresh wild oat seed will be brought up to further infest the crop. If the soil is moist, seed as shallow as possible. An early-maturing barley is the most suitable crop and should be seeded at a slightly heavier rate and a little deeper than is normal. Fertilizer will help to ensure best results.

Flax should not be seeded on wild oat-infested land, unless it is planned to use an herbicide.

Post-seeding Cultivation

Rod weeders, cable weeders or harrows can be used to advantage to destroy wild oat plants after the crop has been seeded. Seeding should be done a little deeper than normal. Begin cultivation when the sprout on the grain crop is one-half inch long. To be effective, the surface soil must be dry and relatively free of trash and the weather bright and warm.

Fall Cultivation

Shallow tillage of stubble to cover wild oat seeds is a good practice in heavily-infested fields. The cultivation should be done after the new seeds have had an opportunity to dry — usually in late September or early October. This tillage will provide a seedbed for the wild oats and promote rapid germination in the spring. The machine used will differ with the various soil types.

Cropping Methods

(a) Green feed crops, such as oats, for forage, cut prior to heading of wild oats provide reasonably good control. Wild oats if headed when cut will mature in the sheaf and seeds will be spread in feeding.

(b) Fall-seeded crops such as fall rye can be used to advantage in conjunction with crops of green feed and late-seeded, early-maturing barley in a cleaning up rotation.

(c) Forage crops — Grasses and legumes left down for some years will do much to lessen incidence of wild oats.

Chemical Control of Wild Oats

Diallate (Avadex) is recommended as a pre-planting application for flax, canning peas, sugar beets, rapeseed, mustard and sunflowers, at rates of 1½ to two pounds per acre. The herbicide should be applied in five gallons per acre or more of water at 30 psi and incorporated the same day to a depth of not more than three inches, preferably with a disc type implement. Seeding of the crop may be done immediately or as soon as convenient. The higher rate will give increased control with no injury to these crops.

To control wild oats in barley apply triallate (Avadex BW) at 1.25 to 1.5 pounds per acre before or after the crop is seeded, or apply diallate at 1.25 pounds per acre **after** the crop is seeded. Triallate may also be applied in the fall at rates of 1.25 to 1.5 pounds per acre. In the fall, incorporation into stubble may be unsatisfactory if the moisture supply is low and/or straw cover is excessive.

Fall tillage also reduces the amount of snow cover and increases the hazard of soil erosion. Best results will probably be obtained from triallate applied in the spring at 1.5 pounds per acre **shortly after** the crop is seeded. Pre-seeding tillage may dry out the top few inches of soil and inactivate the chemical. Rain is then needed for reactivation. Barley should be sown at a depth of three inches while moisture is still available. Deep seeding should be avoided. The herbicide should be applied in five gallons or more of water per acre at 30 psi. Incorporate the herbicide in the soil **as soon as possible** the same day to a depth of two inches with a double harrowing or a very shallow discing. A considerable amount of chemical will be lost under hot and/or windy conditions if incorporation is delayed.

To control wild oats in wheat apply triallate at one to 1.25 pounds per acre **shortly after** the crop is planted. Seeding and spray operations are as for barley. Damage to wheat from triallate may be expected in heavy clay soils unless the seed is planted at least 0.5 inches below the treated layer of soil. Wheat should be seeded at above the minimum rate to compensate for possible thinning.

Barban (Carbyne) is recommended as a post-emergent application to barley, spring and durum wheat at rates of four to five ounces per acre in five gallons of water at pressures not less than 45 psi. Increasing spray pressures up to 90 psi, increases the effectiveness of barban. Spray nozzles directed 45° forward appear to give best results. Winter wheat should not be sprayed in the spring. The chemical must be applied when the majority of the wild oats are in the **two-leaf stage**. Best results are obtained under good growing conditions wherein the wild oats reach the two-leaf stage in less than 11 days after emergence. The four ounce rate is recommended for light to moderate infestations (up to 150 wild oats plants per square yard). The higher rate should be used in heavy infestations, where coverage is difficult due to shading or under adverse growing conditions, such as extended low temperatures near or below freezing, lack of moisture, excessive wind or heat. Damage to wheat and barley may occur if treatment is made after the crop has passed the three-leaf stage or 14 days or more after emergence.

The chemical kills or stunts the wild oats plants preventing or reducing competition within the crop. The effect is gradual and may not be evident for two to three weeks after spraying. The degree of control is largely dependent upon the uniformity of emergence of the wild oats.

Barban at a rate of four to six ounces per acre is also recommended for the control of wild oats in flax, canning peas, mustard, rapeseed, sugar beets and sunflowers. Directions as to sprayer operation and growth stage of the weed are as for wheat and barley.

Green Foxtail

A good stand of crop will assist in the control of this weed. To ensure maximum competition prepare a good firm seedbed and seed early. Seeds germinate mainly during late May and early June under warm temperatures and with good moisture at the soil surface. Light to moderate infestations can produce relatively high yields of seed, e.g., 10 - 100 pounds per acre. Moderate to heavy infestations 200 to 400 plants per square yard are required to reduce the yield of barley.

Summerfallow tillage should be shallow to keep the seeds near the surface so that they will germinate.

For the control of green foxtail in barley or oats (but not in wheat) apply TCA at one to two pounds per acre when the weed is in the one to two-leaf stage and the crop within the two to three-leafstage. Use one pound per acre on sandy soils. Higher rates may cause delay in maturity on sandy soils. Barley is more susceptible than oats to injury, which may be a delay in maturity but usually this will not affect yields. For greater crop safety apply in not less than eight to 10 gallons of water per acre.

It is recommended that applications be made on small acreages until experience has been gained with the use of the herbicide. Since TCA acts primarily through the soil, the activity of the herbicide will be greater on sandy soils and under good moisture conditions. It is advisable not to make applications on oats and barley seeded less than two to three inches deep.

Mixtures of TCA and amine or sodium salts of MCPA at up to eight ounces per acre have given satisfactory results for the control of green foxtail and broadleaved weeds susceptible to MCPA.

Green foxtail can be controlled in flax, rapeseed and sugar beets with TCA at four to six pounds per acre or dalapon at .75 to 1.25 pounds per acre applied during the seedling to three-leaf stage of the weed. Spray application procedures are as for barley and oats.

Wild Buckwheat

Infestations can be reduced by good cultural practices. Delay seeding until early-emerged wild buckwheat has been destroyed by tillage. Harrowing or rod weeding after seeding will give further control.

Chemicals can be used to control or suppress wild buckwheat in growing cereal crops. Mixtures containing 1.5 to two ounces per acre of dicamba and 4.5 to six ounces per acre of 2,4-D or MCPA will give excellent control. Such mixtures can be used on wheat, oats, or barley with the provision that in barley the rate of dicamba should not exceed 1.5 ounces per acre. Bromoxynil ester at four to six ounces per acre, alone or in mixture with 2,4-D or MCPA, will also control wild buckwheat effectively in wheat, oats, or barley, particularly when the weeds are in the early stage of growth.

Other herbicide treatments that may be used to control wild buckwheat include a 1 : 1 mixture of 2,4-D and dichlorprop at 12 to 16 ounces per acre. The latter mixture may not result in complete kill. The 2,4-D alone at the highest rate recommended for the crop (eight to 12 ounces per acre) or in two five-ounce per acre applications one week apart will result in growth suppression and reduced seed production of wild buckwheat.

In grain crops undersown with alfalfa, 2,4-DB ester at 20 to 24 ounces per acre in 15 to 20 gallons of water per acre can be used to give partial control.

Tartary Buckwheat

Tillage and cropping practices used for other annual weeds apply also to Tartary buckwheat. Excellent chemical control in wheat and oats can be obtained with mixtures containing two ounces per acre of dicamba plus six ounces of 2,4-D or MCPA. The presence of a small amount of mecoprop in these mixtures does not substantially alter the effectiveness of the treatment. Treatment before the weed is in the four-leaf stage will result in most effective control. Barley is more sensitive to dicamba than is wheat or oats, and mixtures applied to barley should not contain more than 1.5 ounce per acre of dicamba.

Bromoxynil ester at four to eight ounces per acre will result in good to excellent control of Tartary Buckwheat if applied during the one to four-leaf stage of growth of the weed. The effectiveness of later applications will depend at least partly on prevailing growing conditions.

Mecoprop at 16 to 20 ounces per acre in 20 gallons of water per acre will give virtually complete control without injury to wheat, oats, or barley. A 1 : 1 mixture of 2,4-D and dichlorprop at 12 to 6 ounces per acre will control Tartary Buckwheat but may not result in complete kill.

The 2,4-D or MCPA ester at the highest rate recommended for the crop will result in suppression and partial control of Tartary Buckwheat but will seldom achieve complete eradication. Seed production will be reduced as a result of these treatments but will not be completely prevented.

In grain crops undersown with alfalfa, 2,4-DB ester at 20 to 24 ounces per acre in 15 to 20 gallons of water per acre may be used to give some degree of control.

Green Smartweed

Chemical control of green smartweed can be effectively achieved by treating with mixtures containing 1.5 to two ounces per acre of dicamba and 4.5 to six ounces per acre of 2,4-D with or without some mecoprop. These mixtures can be used on wheat, oats, or barley, with the provision that in barley the dicamba dosage should not exceed 1.5 ounces per acre. Bromoxynil ester at four to six ounces per acre will also result in excellent control. Treatments should be applied during the one to four-leaf stage of the weeds for best results. Application of 2,4-D ester at the maximum dosage for the crop will result in some suppression. But such treatments will be much less effective, though also less costly, than the treatments referred to.

PERENNIALS

Couchgrass (quackgrass)

Tillage offers the only feasible means of control. Start operations just before freeze-up. Till thoroughly as by rotovating, plowing or one-way discing. Next year, as soon as the grass has about two inches of top growth, resume tillage and repeat whenever regrowth approaches this height.

Use a rotary or disc implement and shred the rootstocks thoroughly to induce starvation by growth. Continue this practice if the soil remains moist. If the soil becomes dry and the rootstocks become dormant, use a cultivator equipped with chisel points followed by a cable or rod weeder to lay the rootstocks on the surface to dry out. Should the soil again become moist, resume work by a disc or rotary implement. Take care not to drag rootstock pieces to clean parts of the field.

During seasons of heavy rainfall which restrict cultivation, mowing or grazing to prevent heading is desirable. Heavy pasturing prior to initiating cultivation will make eradication easier.

Patches of couchgrass can be controlled by TCA used as a "short-term" soil sterilant. In the spring, rotovate or disc thoroughly and harrow. Follow in the next three to seven days by an application of TCA at 40 pounds per acre (1½ ounces per 100 square feet). The warmer and moister the soil, the sooner

the TCA should be applied. Use at least 80 gallons per acre of water and apply uniformly. Incorporate the herbicide immediately by rotovating or discing. Two to three weeks later again rotovate or disc thoroughly. Till again at monthly intervals until freeze-up. In drier areas and years the effect of TCA may extend into the next growing season.

To eradicate small patches or stray couchgrass plants use any of the following total vegetation control herbicides: sodium chlorate at two to three pounds per 100 square feet; monuron at one to two ounces; atrazine at 2½ to three ounces; and bromacil at ½ ounce per 100 square feet. At these rates, the residual effect of these herbicides will prevent the normal development of crop plants for two or more years.

For quick knock-down of top growth add paraquat at three pounds per acre (one tablespoonful of actual product per 100 square feet) to the monuron, atrazine, and bromacil sprays just before application.

Canada Thistle and Perennial Sowthistle

Near-complete to complete eradication can be achieved by a full season of intensive tillage, beginning immediately after harvest and continuing until freeze-up of the following year. The tillage operations may be discontinued in mid-June. The thistles may be treated with the ester of 2,4-D or MCPA at not less than 16 ounces per acre, the ester of 2,4-DB at two pounds per acre, or mixtures of dicamba and phenoxy herbicides at rates above eight ounces per acre when in the late bud stage. Tillage should proceed as soon as regrowth appears and be given as needed until freeze-up.

The top growth of these weeds can usually be killed and seed formation prevented by the use of the ester of 2,4-D or MCPA at eight to 12 ounces per acre in oats and flax, dicamba at two to four ounces per acre alone or at two ounces per acre in a two or three-way mix with MCPA and mecoprop in wheat and oats, or a 1 : 1 mixture of bromoxynil and phenoxy herbicides at a rate of eight to 10 ounces per acre in wheat, oats, and barley. Some injury to grain crops may be expected from the above mentioned treatments. The 2,4-D is slightly more effective than is MCPA on perennial sowthistle. Cereals undersown with alfalfa, red clover or white clover may be treated with 2,4-DB at 24 ounces per acre. MCPB may be used at 20 to 24 ounces per acre for thistle control in flax, peas, and seedling clovers (except sweet clover), and 2,4-DB at the same rate should be used in seedling alfalfa.

In grass hay or pasture fields, annual treatment with 2,4-D at 16 ounces per acre when thistles are in flower-bud stage will reduce the stand of the thistles. In pastures containing ladino and alsike clover, treatment with MCPB at 24 ounces per acre should be used rather than 2,4-D.

Infested areas around slough edges, on roadsides, and in other uncultivated sites may be seeded to a suitable and strongly competitive grass and treated annually with 2,4-D.

On non-crop land, repeat dosages of 2,4-D at 16 ounces per acre will control, if not eradicate, these weeds when treatments are applied at bud to first bloom. Soil sterilants such as sodium chlorate or chlorate-borate compounds at three pounds per 100 square feet, borate-TBA at ½ to one pound of product per 100 square feet, or monuron at two ounces per 100 square feet, will kill most of the thistles. But their use is practical only in small patches. Treatment should be made for a distance of not less than six feet beyond the limits of the patch. Other materials that can be used for small patches are picloram at one pound per acre and dicamba at two pounds per acre.

Field Horsetail

The top growth of this weed can be effectively suppressed by four ounces per acre of the ester of MCPA applied when it is completely emerged. At this time, the cereal crop will be at an advanced growth stage, and spraying should be done either at early shot blade or at a post-flower stage. The 2,4-D can be used in place of MCPA but there is more chance of injury to the cereal crop.

The annual use of MCPA for top-growth kill of horsetail in cereals will reduce the stand of the weed.

Toadflax, Leafy Spurge, Hoary Cress, Field Bindweed, Russian Knapweed, and Bladder Campion

On crop land, intensive tillage of fallow will reduce the stand of these weeds sufficiently to permit successful crop production the following year. Eradication by continued intensive tillage is possible, but must be continued into the third season. Because of the danger of erosion, cultural methods should be confined to limited areas of relatively narrow strips.

Grass may be seeded on infested areas after a season of intensive cultivation. Yearly spraying with the ester of 2,4-D at 24 to 32 ounces per acre will reduce the stand and vigour of these weeds. Such seeding and treating procedure is recommended for poorer crop lands.

Small patches can be controlled by the use of the same soil sterilants mentioned above for thistles, using 1½ times the rates suggested for thistles. Areas treated with soil sterilants should not be cultivated for at least one year and retreatment should be given if regrowth appears. If seedlings appear, they may be tilled or treated with 2,4-D ester at 24 ounces per acre.

Some other herbicides are useful for the control of specific weeds. For example, 2,4-D at five to eight pounds or amitrole at four to six pounds per acre can be used for hoary cress; 2,3,6-TBA at 15 to 20 pounds per acre for toadflax, leafy spurge, field bindweed and Russian knapweed; and 2,4-D-borate mixture at 1.5 to two pounds of product per 100 square feet for toadflax and leafy spurge. The last mentioned herbicide can be used when toadflax and leafy spurge are to be controlled in grassed areas. Picloram at 1.5 to two pounds per acre may be used on these species on land not used for crops.

Top growth of leafy spurge, hoary cress, and field bindwood can be controlled in grain crops with the ester of 2,4-D at eight to 12 ounces per acre.

CONTROL OF BRUSH AND TREES

Brush killing mixtures are generally a combination of 2,4-D and 2,4,5-T. Where all the species to be controlled are susceptible to 2,4-D (see Woody Plants classification) this chemical is recommended by itself since it is cheaper than 2,4,5-T. Often it is necessary to make at least two treatments. Where mixtures are used, the most efficient ratio is usually two parts 2,4-D to one part 2,4,5-T. Commercially prepared brushkillers usually contain one part of 2,4-D to one part 2,4,5-T.

There are three main methods of killing brush and trees with chemical. :

Foliage Spraying — Spray as soon as the leaves are fully expanded. Use 2,4-D ester, 2,4,5-T, or mixtures of the two, depending on the species present. Wet all foliage thoroughly using two to four pounds of total acid equivalent in 10 or more gallons of water per acre. Close stands of tall poplars on pasture lands usually cannot be killed by one spraying. Therefore, a mechanical clearing operation followed by spraying of the regrowth is recommended.

Over-all Dormant Spraying — This is done during the absence of foliage. A mixture of 2,4-D and 2,4,5-T should be used. Two to four pounds of the mixture should be applied in 10 to 15 gallons of diesel fuel per acre.

Basal Bark and Stump Treatment — For basal bark treatment, apply the chemical from a height of two feet down to the ground line. For stump treatment, cover the entire stump. In each case, the bark at the ground line and the protruding roots should be wetted until the liquid begins to run off. A solution of 1½ pounds of total acid of 2,4-D ester or mixtures of 2,4-D and 2,4,5-T in 10 gallons of diesel oil is recommended.

Classification of Woody Plants According to Their Response to Herbicides

Group 1 — Susceptible to 2,4-D

Caragana	Lilac	Saskatoon
Chokecherry	Manitoba Maple	Snowberry
Currants	Pincherry	Spirea
Hazelnut	Poplar, Aspen	Willows
Honeysuckle	Poplar, Balsam	Wolf Willow

Group 2 — Resistant to 2,4-D

Shrubby Cinquefoil	Raspberry
Oak	Rose

Group 3 — Apparently more susceptible to 2,4,5-T than to 2,4-D

Ash	Bearberry	Dogwood
Hawthorn	Raspberry	Rose
Poison Ivy	Caragana	

PRECAUTIONARY MEASURES WHEN USING HERBICIDES

1. The chemicals 2,4-D and MCPA are non-poisonous and non-flammable. They are no more corrosive to metal and rubber than is water. Excessive breathing of the fumes may cause nausea to some persons.

2. Whenever systemic herbicides such as 2,4-D, 2,4,5-T, and MCPA are used there is danger of spray, dust, or vapour drift. Therefore, when such herbicides are used in the vicinity of susceptible crops, gardens, and shrub or tree plantations, suitable precautions should be taken to prevent drift, and the salt forms (sodium or amine) or the low volatile esters should be used.

3. After storage shake or stir 2,4-D thoroughly before using. Large drums of the chemical may be mixed with a gasoline toggle pump.

4. When applied in excessive quantities, 2,4-D and MCPA will kill a very wide range of plants. Warning is therefore given not to apply rates higher than the maximum recommended for the respective crops and weeds, and to be sure that spraying and dusting machines spread the chemicals uniformly.

5. It is recommended that receptacles, containers, machines, and handgun hose, used for applying systemic herbicides, should not be used for the application of fungicides and insecticides to susceptible crops. If they must be used, thorough cleaning is necessary. Rinse with water containing a small amount of detergent and fill with a weak solution of household ammonia (one cup of ammonia to each three gallons of water will do). Run some solution through the sprayer, allow to stand overnight, drain, and rinse thoroughly with water. Handgun hoses should never be used to transfer drinking water.

6. Sodium chlorate is flammable but can be used to advantage if proper precautions are taken. Some commercial preparations of sodium chlorate contain fire-retardant materials and therefore are safer to use.

7. Care should be taken not to place herbicides, especially soil sterilant compounds, in the feeding zone of desirable trees.

8. Do not use herbicides where they may contaminate water used for irrigation or drinking purposes.

9. Do not store systemic herbicides close to seeds, fertilizer, insecticides, or fungicides because of the danger of contamination by leaked or spilled herbicide or by its vapors.

Remember! Chemicals are Made to Kill Plants — Make sure that they Kill Only Undesirable Plants.

REFERENCE

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Soil Sterilants	80	641
Alberta Extension Service		
Control of Tartary Buckwheat in Alberta	52	——
Green Foxtail in Alberta	——	642-11
Lawn Building and Maintenance	——	273/70
Chemical Weed Control in Field Crops, 1966	——	641-1

GRAIN VARIETIES

The production of cereal and oilseed crops continues to be one of Alberta's most important agricultural enterprises. In 1967 approximately 13,000,000 acres will be seeded to wheat, oats, barley, and rye and better than 1,000,000 acres will be seeded to oilseed crops including flax, rapeseed, mustard, and sunflowers. Another six to seven million acres will be in summerfallow to be used for the production of one or more of the named crops next year. Including the fallow, approximately 77 per cent of Alberta's improved farm land will be used for the production of cereal and oilseed crops.

Returns will amount to approximately 400 million dollars in 1967 based on current cash market prices. While these values are realistic for the oilseed crops, the actual returns from the main grain crops will be higher because of the large quantities marketed through livestock.

To assure that this important farm enterprise will continue to thrive, new and improved varieties are being developed continually. In Alberta, the responsibility for improvement rests with plant breeding teams located at the University of Alberta and the Canada Department of Agriculture Research Units at Lethbridge, Lacombe, and Beaverlodge. These establishments work in close co-operation with other plant improvement institutions in Canada. They are continually evaluating any new varieties that may prove promising for production in Alberta. Varieties introduced or developed through breeding and selection, are tested for several years before being released for general growing by farmers.

Some varieties of special value to Alberta farmers released in recent years include Park and Cypress spring wheat; Winalta winter wheat; Pendek and Hamron oats; Gateway 63, Galt, Palliser, and Conquest barley; Frontier fall rye; Noralta flax; and Echo, Tanka, and Target rapeseed. With the exception of Pendek oats, which is an introduction from Holland, all of the above varieties were developed in plant breeding programs conducted in Canada. Seven of the 13 varieties were developed by Alberta establishments.

The development and release of these improved varieties, however, is but one link in the overall production picture. Cultural, fertilizer, crop sequence, and seed treatment practices exert a marked influence on the production of cereal and oilseed crops. Detailed information on these subjects may be found in other sections of the Guide.

The use of top quality seed is another factor that can influence crop production. When a variety is licensed for sale in Canada the responsibility for the increase of high quality pedigreed seed rests with members of the Canadian Seed Growers Association. Selected seed growers are provided with Breeders' Seed from which Foundation, Registered, and Certified Seed is produced. Established Foundation Stock Seed Growers produce First Generation Registered Seed. Second Generation Registered is produced from First Generation. In most cases Certified Seed is produced from Second Generation Registered Seed. Unless seed stocks of a variety are in short supply a crop produced from Certified Seed is not eligible for pedigreed status.

All pedigreed seed is subject to field and seed inspection by the staff of the Plant Products Division, Production and Marketing Branch, Canada Department of Agriculture. Pedigree records and Crop Certificates are maintained and issued by the Canadian Seed Growers Association.

The purchase of pedigreed seed assures the grower he is obtaining top quality seed of the variety best suited to his production program. It is recommended that all farmers use pedigreed seed, at least at frequent intervals. Unless one is in the seed production business, Certified Seed is adequate to assure purity and quality for commercial production.

If pedigreed seed is not purchased it is essential that grain intended for seeding be tested for germination. Frost, moisture, and other conditions may lower the percentage of germination as well as the vitality of the seedlings. Tests can be conducted at home in sand or soil. However, the best method is to have seed tested at a testing laboratory. Elevator agents will send your samples away for laboratory testing which may include determination of seed-borne disease organisms.

For an official germination test, required for seed to be offered for sale, samples must be sent to the Plant Products Division, Canada Department of Agriculture, Federal Building, Edmonton, Alberta. The fee for testing of cereals is $1.50 for each sample payable when the sample is submitted.

The Alberta Varietal Advisory Committee operates in Alberta to co-ordinate the findings of various experimental agencies and to summarize information for use by farmers. This committee is composed of representatives of the Department of Genetics, University of Alberta, Edmonton; the Research Stations and Experimental Farm, Research Branch, Canada Department of Agriculture, Lethbridge, Beaverlodge, and Lacombe; the Plant Products Division, Production and Marketing Branch, Canada Department of Agriculture, Edmonton; and the Plant Industry Division, Alberta Department of Agriculture, Edmonton.

This committee meets every year and prepares Publication No. 91, entitled "Varieties of Grain for Alberta", which is made available early in each calendar year. It is given wide distribution through grain and seed trade channels and may also be obtained from any of the agencies represented on the committee or from local district agriculturists.

In central and northern Alberta the following may be used as a guide for estimating maturity in actual days from seeding to harvest when the crops are seeded on fallow land: wheat—Thatcher, 120 days, Saunders, 116; oats—Eagle, 112, Glen, 106; barley—Husky, 108, Olli, 92; flax—Redwood, 130 and Redwing, 115 days. In southern Alberta Thatcher can be expected to mature in 100 to 105 days and other crops are similarly earlier maturing. The comparisons among varieties within crops, however, tend to remain fairly uniform regardless of where the crops are grown.

The following information was made available in Publication No. 91 to farmers for 1966 planting. To be assured that latest information is available at all times, the most recent copy should be obtained as soon as possible after each publication.

RYE

Rye is not a major crop in Alberta since it occupies only about one per cent of the total crop acreage. Fall rye makes up about 85 per cent of the total rye acreage and is useful as a good weed control crop. Both spring and fall rye are well suited for production on sandy soil.

Antelope, Frontier, Petkus, and Sangaste are varieties of fall rye suitable for Alberta. Antelope and Frontier are more winter hardy than Sangaste which in turn is hardier than Petkus. Petkus and Sangaste have large seeds, Frontier has medium, and Antelope small seeds. If no winter killing occurs Petkus and Frontier will yield the highest followed by Sangaste, then Antelope. Prolific is a suitable variety of spring rye.

DURUM WHEAT

The production of Durum (macaroni) wheat varieties should be restricted to southern areas because of their late maturity. They are similar to hard red spring wheat in yield, but are generally more susceptible to lodging. Mindum, Ramsey, and Stewart 63 are suitable varieties for production in Southern Alberta.

SOFT WHITE SPRING WHEAT

This crop should be grown only under contract with a milling company.

HARD RED WINTER WHEAT

Winter wheat production is presently concentrated in the south-western portion of the province. Production in other areas is limited because of marketing problems and periodic winter killing.

Kharkov 22MC and Winalta are the most winter hardy varieties available and yield about the same. Yogo is equal to these varieties in yield, is more resistant to bunt, but less resistant to lodging. Winalta is superior to Kharkov and Yogo in milling and baking quality, earlier maturity and more resistant to shattering.

DESCRIPTION OF VARIETIES — FLAX

Variety	Relative yield in per cent in Areas 1-2	Areas 3-4	Relative Maturity	Seed Size	Rust Resistance	REMARKS :
Cree	104	104	Med-late	Med.	Fair	Late-maturing for northern areas.
Marine	—	97	Med-early	Small	Fair	May be difficult to thresh.
Noralta	105	105	Med-early	Small	Good	Suitable to all areas. Resistant to lodging.
Raja	102	99	Med-early	Large	Good	Responds well to delayed seeding in the south.
Redwing	100	100	Early	Small	Poor	Resistant to lodging.
Redwood	106	100	Late	Med.	Good	Suitable to southern areas.

RAPESEED

Rapeseed production is best suited to the black and the grey-wooded soils of Alberta. Production of rapeseed was negligible until about the mid-1950's and has steadily increased in importance since. In 1965, the Alberta acreage reached 735 thousand acres and some 680 thousand acres were seeded in 1966.

Insects and diseases can be a problem in rapeseed production if careful cultural practices are not followed. Please refer to the section on Plant Diseases and Crop Insects.

There are two types of rapeseed being grown in Alberta. Polish rape requires from 90 to 100 days to mature while Argentine rape ripens some three weeks later. Polish rape is more resistant than Argentine to spring frost and shattering. Echo is a high yielding variety of the Polish type and Golden, Nugget, Tanka and Target are good-yielding varieties of the Argentine type.

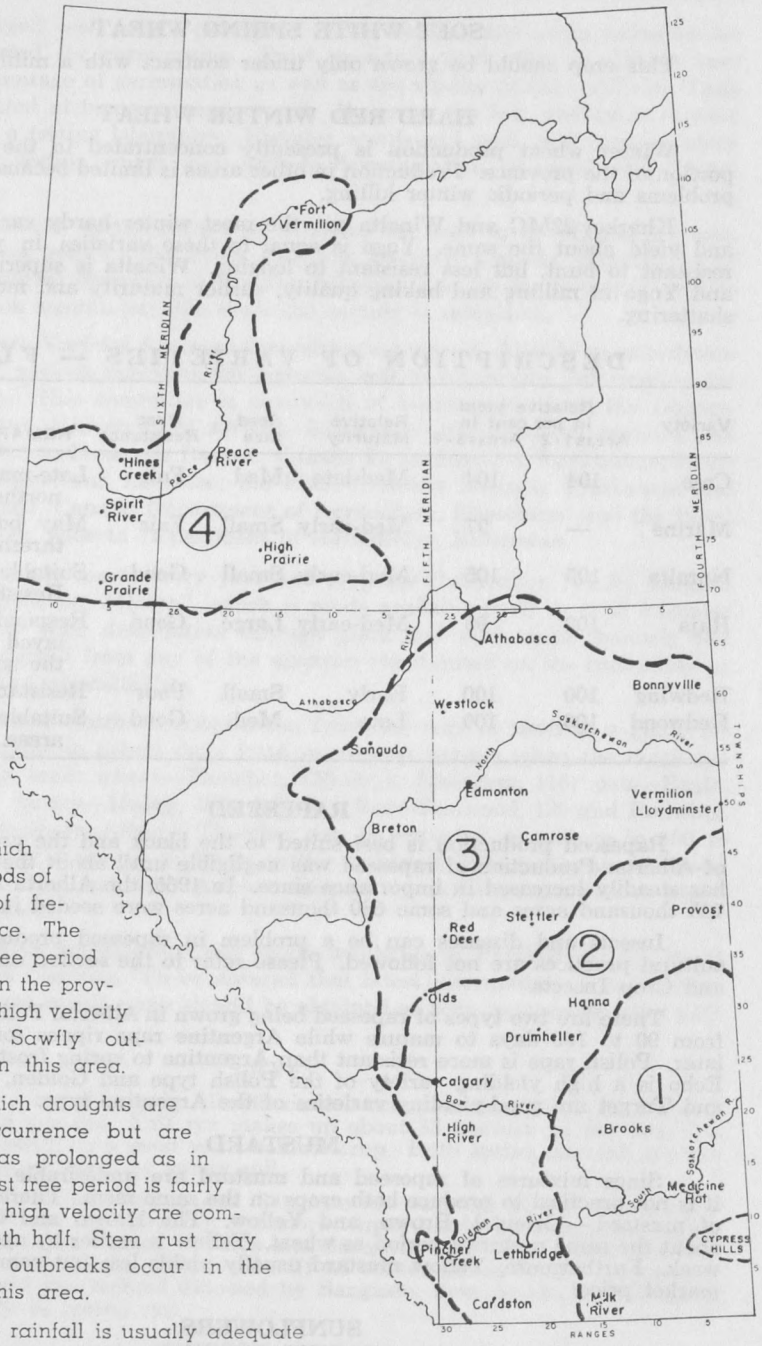
MUSTARD

Since mixtures of rapeseed and mustard are undesirable and inseparable it is not practical to produce both crops on the same farm. There are three types of mustard — Oriental, Brown, and Yellow. The Brown and Oriental require about the same maturity period as wheat. Yellow is earlier by approximately one week. Furthermore, Yellow mustard usually yields less but commands a higher market price.

SUNFLOWERS

The introduction of earlier maturing varieties has extended the area in which sunflowers may be grown to maturity. However, this crop should only be grown under contract to assure a market for seed produced. Information concerning varieties and production practices will be supplied by the contracting firms.

Map of Alberta Showing Grain Production Areas



1. An area in which prolonged periods of drought are of frequent occurrence. The average frost free period is the longest in the province. Winds of high velocity are common. Sawfly outbreaks occur in this area.
2. An area in which droughts are of common occurrence but are generally not as prolonged as in Area 1. The frost free period is fairly long. Winds of high velocity are common in the south half. Stem rust may occur. Sawfly outbreaks occur in the south half of this area.
3. An area where rainfall is usually adequate for cereal and oilseed crops. Frost may be a hazard in the western and northern portions. Stem rust may occur in the eastern portion.
4. An area where rainfall is usually adequate for cereal and oilseed crops. The frost free period may be somewhat shorter than in Area 3 but because of longer days the growth is usually more rapid.

DESCRIPTION OF VARIETIES — WHEAT

Variety	Relative yield in per cent in areas 1	2	3	4	Relative Maturity	Resistance to: Lodging	Shattering	Stem Rust	REMARKS:
HARD RED SPRING WHEAT									
Canthatch	100	100	100	100	Medium	Good	Good	Good	A widely adapted variety — kernels tend to bleach.
Chinook	97	95	—	—	Medium	Fair	Poor	Fair	Suited to sawfly area — retains good bushel weight under dry conditions.
Cypress	97	95	—	—	Medium	Fair	Fair	Fair	Similar to chinook, with better resistance to sawfly.
Garnet	—	—	92	94	Med-early	Poor	Poor	Poor	Low baking quality — separate grades.
Manitou	100	100	100	100	Med-late	Good	Good	Good	Late maturing in Areas 3 and 4.
Park	—	95	97	95	Med-early	Good	Good	Fair	Easier to thresh and bleaches less than does Thatcher.
Saunders	—	90	92	96	Med-early	Good	Good	Fair	Best suited to Area 4.
Thatcher	100	100	100	100	Medium	Good	Good	Fair	A widely-adapted variety — kernels tend to bleach.
DURUM WHEAT									
Ramsey	100	100	—	—	Late	Fair	Good	Good	Because of late maturity Durum wheat should be grown only in Area 1 and the southern portion of Area 2.
Stewart	100	100	—	—	Late	Fair	Good	Fair	
Stewart 63	100	100	—	—	Late	Fair	Good	Good	
HARD RED WINTER WHEAT									
Kharkov 22MC	—	100	100	—	Early	Fair	Poor	Poor	Winter survival is best in southwestern Alberta. Winalta has better milling and baking quality and shorter straw than Kharkov or Yogo.
Winalta	—	104	100	—	Early	Good	Good	Poor	
Yogo	—	105	102	—	Early	Fair	Good	Poor	

DESCRIPTION OF VARIETIES — OATS

Variety	Relative yield in per cent in areas				Relative Maturity	Resistance to: Lodging	Shattering	REMARKS:
	1	2	3	4				
Abegweit	95	100	100	100	Medium	Fair	Good	Best suited to northern areas.
Eagle	103	105	105	102	Late	Fair	Good	Best suited to central areas.
Garry	93	95	91	92	Med-early	Good	Good	Large kernels. Good disease resistance.
Glen	96	100	95	96	Med-early	Fair	Good	Has long, large kernels. Resistant to gray speck.
Harmon	95	100	100	96	Med-late	Good	Good	Kernels similar to Rodney.
Larain	—	—	80	82	Early	Good	Fair	Suitable only if frost is a severe hazard.
Pendek	95	100	95	98	Med-early	Good	Good	Short, strong straw. Resistant to gray speck.
Rodney	95	100	95	96	Med-late	Good	Fair	Large kernels, de-hulls readily.
Victory	100	100	100	100	Late	Poor	Good	Has wide adaptability.

DESCRIPTION OF VARIETIES — BARLEY

Variety	Relative yield in per cent in areas 1	2	3	4	Relative Maturity	No. of rows	Awn Type	Resistance to: Lodging	Shattering	Loose Smut	REMARKS:
ELIGIBLE FOR FEED GRADES ONLY											
Husky	100	100	100	100	Late	6	Smooth	Fair	Good	Poor	May shatter in southern areas.
Jubilee	100	100	103	102	Late	6	Smooth	Fair	Good	Poor	May shatter in southern areas.
Keystone	102	97	90	90	Medium	6	Smooth	Good	Good	Good	Awns may be difficult to remove.
ELIGIBLE FOR CW GRADES											
Betzes	106	100	93	95	Medium	2	Rough	Fair	Good	Fair	May shatter in drier areas.
Compana	110	95	—	—	Medium	2	Semi-smooth	Poor	Good	Fair	Eligible for 3 CW 2-Row only. Subject to post-maturity stem break.
Palliser	110	100	—	—	Med-late	2	Semi-smooth	Fair	Good	Fair	Eligible for 3 CW 2-Row only.
Conquest	90	90	95	90	Medium	6	Smooth	Good	Good	Good	Best suited to Area 3.
Gateway	—	85	83	90	Med-early	6	Smooth	Fair	Good	Poor	Early enough for delayed seeding. May shatter in southern areas.
Gateway 63	—	87	86	94	Med-early	6	Smooth	Fair	Good	Poor	
Olli	—	—	80	88	Early	6	Rough	Poor	Fair	Fair	
Parkland	—	90	90	90	Medium	6	Smooth	Fair	Good	Poor	Subject to kernel peeling.

FORAGE CROPS

Forage crops are the basis of permanent agriculture and have a place on every farm. They provide the best source of livestock feed and prepare the land for grain crops to follow. They improve soil tilth by their fibre residue and legumes contribute to fertility. Forage crops are widely adapted over Alberta and should constitute a permanent part in the cropping program in all areas. They provide one of the best known means of weed control. They may also be used for reclaiming watercourses, low areas, alkali lands, field margins and roadsides.

How much of your land should be seeded to grass and legume crops will depend on where you farm. The map on page 44 will show the area in which you are living. Keep in mind that the lines between the areas are not clear cut.

Area One — Regular rotations of grain and forage are rarely followed in Area One. With low rainfall, soil fertility declines slowly and it is often difficult to establish forage stands. Forage crops do, however, have a place in this area. They contribute to a more balanced type of farming, prevent soil erosion and improve soil structure. A portion of the cultivated land might well be sown to grass periodically and left down for about five years.

Crested wheatgrass is widely used, particularly for reseeding abandoned wheat land, regrassing over-grazed ranges and for permanent seeding down of light soils that tend to drift readily. The grazing capacity of a good stand of crested wheatgrass is considerably greater than that of native range. Crested wheatgrass and alfalfa is the best mixture for hay in area One. Russian wild-rye provides a useful summer pasture in rotation with crested wheatgrass. Pubescent and intermediate wheatgrasses are also useful in this area both for hay and pastures. The addition of alfalfa to these grasses increases pasture quality and production. It is a recommended practice despite the bloat hazard.

Sweet clover is also useful in Area One since it adds nitrogen to the soil. It should be seeded with the last grain crop that precedes summerfallow.

Area Two — Better moisture in Area Two, allow for greater use and wider choice of forage crops. Crested wheatgrass, Russian wild ryegrass, sweet clover and alfalfa are suitable in the drier sections. In districts of more plentiful moisture, alfalfa, bromegrass, creeping red fescue, pubescent and intermediate wheatgrasses and timothy may be grown to advantage. Throughout Area Two, greater use should be made of sweet clover and alfalfa.

Where forage crops are included in grain-grass rotation they should remain down from three to five years.

Area Three — Because of the good fertility and adequate moisture conditions in Area Three forage crops provide extensive pasture and hay to meet the livestock needs of a mixed farming economy.

Alfalfa and bromegrass are the most useful forage crops, but all winter-hardy grasses and legumes can be grown successfully. Red clover, alsike clover, timothy, pubescent and intermediate wheatgrasses and creeping red fescue all are suitable.

Area Four — In this area—the grey wooded—land that is more than two to four years away from forage should not be seeded to grain. Legumes must be grown if the land is to yield profitably. Since, under natural conditions, the soil contains very little fibre, grasses are essential too. Alfalfa, clovers, brome, timothy and creeping red fescue are all important forage crops in this area.

In the improvement of grey wooded soils, legumes and fertilizer should be used together. Forage yields in this area are often more than doubled by fertilizer application. Yields of grain following fertilized legumes usually show marked increases.

Nitrogen, phosphate and sulphur are the elements usually lacking. Nitrogen can be supplied by growing legume crops but phosphate and sulphur must be supplied in the form of commercial fertilizer.

Irrigated Areas — Irrigation makes possible the use of a wide range of forage crops in southern Alberta.

Much of the economy of irrigated areas lies in the production of cash crops, which are grown in a rotation system with forage crops. Alfalfa is very important to permanent agriculture in the irrigated areas. It provides the main feed source for livestock, and acts as the best soil conditioner for other crops. Sweet clover is used in short rotations in conjunction with sugar beet growing.

There has been a marked increase in irrigated pastures, which are now used extensively for beef and mutton production.

Alfalfa is the main hay crop on irrigated land but brome, creeping red fescue, orchardgrass, pubescent wheatgrass and the clovers are used extensively. White clover is an important pasture legume. Pubescent wheatgrass, tall wheatgrass, reed canarygrass, and Alta fescue all play an important role on irrigated farms.

Fort Vermilion Area — Rainfall is light but variable and a tendency towards dry conditions in the early spring exists. The growing season is short restricting forage species to the more hardy varieties of alfalfa, bromegrass, crested wheatgrass and creeping red fescue. A deficiency of soil nitrogen makes alfalfa an essential part of any forage mixture. Nitrogen fertilizer can be applied to advantage on two-year-old or older forage stands.

FORAGE CROP VARIETIES

ALFALFA — does best on moist but well drained soils. It is unequalled as a forage crop.

Ladak is sufficiently winter hardy for most areas of Alberta. It is high in forage yield and partially resistant to bacterial wilt.

Beaver is equal to Ladak in forage yield, but considerably more resistant to bacterial wilt. It is the most suitable variety for irrigated and other moist areas of the province.

Rambler is a creeping-rooted variety especially useful for dry land pasture. It is very drought resistant and winter hardy.

Roamer is a new creeping-rooted variety licensed in 1966. It has better wilt resistance and produces higher seed yields than Rambler.

Vernal has good wilt resistance but hardiness in areas outside the irrigation districts.

ALSIKE CLOVER — Useful where moisture is adequate; on low lands, in areas subject to flooding and in irrigated areas.

Aurora is the recommended variety.

RED CLOVER — Generally adapted to the grey wooded and black soils. It requires ample moisture and good drainage. Thrives under irrigation.

Altaswede is a single cut red clover. It is a tall growing, late maturing, high yielding variety with moderate resistance to disease.

SWEET CLOVER — A biennial crop of wide adaptation. It is useful as a fodder crop and in rotations as a green manure crop. Once established, it is fairly alkali tolerant.

(a) **WHITE BLOSSOM**

Arctic is the standard white blossomed sweet clover for western Canada. It is hardy, has medium fine stem, good leafiness and high forage yield. It is a few days earlier than common white.

(b) **YELLOW BLOSSOM**

Erector is much more uniform and somewhat more upright than common yellow and is higher yielding. It flowers a few days earlier than Arctic.

WHITE CLOVER (commonly called White Dutch Clover) is an important irrigated pasture legume and is also used in the more moist parts of Areas Three and Four.

Ladino, a more productive white clover, lacks winter hardiness and is limited to the irrigated areas.

Merit and Pilgrim are Ladino types used in irrigated areas of southern Alberta.

BIRDSFOOT TREFOIL — A fine stemmed, non-bloating pasture legume. It requires more light than other forages in the establishment year and therefore companion crops, if used, should be removed as pasture. Birdsfoot trefoil is not quite as hardy and persistent as alfalfa.

Leo is the hardiest and highest yielding variety.

BROMEGRASS — The most commonly used grass in Alberta. It is adapted to a wide range of soil and moisture conditions, but thrives particularly well on moist, well-drained soils. It is a hardy, long lived, high yielding, creeping rooted perennial which makes good summer pasture and excellent hay.

Carlton, a variety of the northern type produces excellent seed and forage yields.

CREEPING RED FESCUE — A useful grass except where moisture is limited It produces good pasture from spring to late fall and can be used for winter grazing. It is one of the best cultivated pasture grasses in the foothills and forms a dense turf that withstands severe trampling.

Boreal is a recently-developed variety expected to replace Olds. It is more uniform in all growth characteristics including seed ripening.

Olds is a high yielding hardy variety.

CRESTED WHEATGRASS — Thrives on the dry, open plains and on sandy soils in other areas. Makes early spring and late fall growth. It has an extensive root system. It is one of the best grasses for the drier areas of western Canada and has performed well as pasture and as hay in the parkbelt region. Produces well in mixtures with alfalfa in all areas.

Summit is a high yielding hay and pasture type.

Nordan is similar in forage yield and type to Summit but is a better seed producer.

Fairway a fine stemmed, lower yielding variety useful for dry land lawns and roadside seeding.

INTERMEDIATE WHEATGRASS — Grows well in moist areas where bromegrass is adapted, but is not equally hardy. Makes good hay and pasture.

Chief is a high yielding variety.

PUBESCENT WHEATGRASS is a large seeded, creeping perennial. Produces good hay and pasture yields and is suitable for waterways and erosion control. It is very easy to establish.

Greenleaf is the highest yielding variety available in Canada both for forage and seed. The variety was selected for superior seedling vigor and improved winter hardiness. It is somewhat greener in color than common pubescent wheatgrass.

SLENDER WHEATGRASS is a short lived perennial adapted to moderately alkali areas. It produces high quality hay and fair pasture.

TALL WHEATGRASS is the most alkali-tolerant cultivated grass for Alberta. It withstands spring flooding but is subject to winter killing.

Orbit is the hardiest variety.

ORCHARDGRASS — is an excellent grass under irrigation and the basis of permanent pasture mixtures in irrigated areas. It is high yielding and has most rapid recovery after grazing. Grows well in the moist areas of the southern half of Area Three.

Chinook is the most winter hardy variety. Early spring vigor is one of its attractive features. It is the only recommended variety in Alberta.

TIMOTHY — Likes rich, moist soils and cool temperatures. It is suitable for hay in short rotations in Areas Three and Four. It survives spring flooding and wet conditions.

Climax is a tall, upright, relatively fine stemmed leafy variety. It is late maturing. Two additional varieties, Champ and Bounty were licensed in 1966.

RUSSIAN WILD RYEGRASS is very drought tolerant and an excellent pasture grass for the dry and semi-dry areas of the province. Russian wild ryegrass is characterized by poor seedling vigor and therefore is often difficult to establish. It makes excellent summer and late fall pasture.

Sawki is a high yielding variety.

REED CANARYGRASS has very high flooding tolerance and some alkali tolerance. Seed shatters readily. It forms a tough sod and makes good pasture. It makes good hay or silage if cut at early heading. It requires ample nitrogen supply. It is used with alfalfa for hay under irrigation.

Frontier is the only licensed variety in Canada and is an excellent forage producer but seed production is difficult due to high seed shatter.

SEEDING PRACTICES

Seeds of different varieties look alike and varieties cannot be identified on the basis of seed characteristics. Only by purchasing certified seed can you be sure of getting the performance you expect from the variety selected. Certified seed has a pedigree that can be traced by record to the plant breeder stock. For complete confidence in your seed purchase, ask for certified seed. It has varietal purity guaranteed as well as freedom from weeds and diseases.

SEED BED PREPARATION

A firm clean seed bed is essential. In areas where soil drifting is a problem, some form of protection must be provided for the seedlings. This is best accomplished by seeding into clean, undisturbed grain stubble. Where stubble is not available a light seeding of oats will provide protection (see Companion Crops). In other areas, clean fallow land is suitable after packing.

COMPANION CROPS

In general, companion crops are not recommended as they provide too much competition to the forage seedlings. However, under drifting or eroding conditions and in high rainfall areas, they can be used successfully. Where used, the recommended crop is oats at one-half the usual rate seeded in a separate operation from the forage crop. The oats should be removed early as pasture, silage or as green feed.

INOCULATION

All legume seed should be inoculated at the time of seeding. Recommended inoculants are available from seed houses and should be applied just prior to seeding.

TIME TO SEED

Seeding to coincide with favorable moisture conditions is the most important factor in establishing forage stands. In general it can be done at three times of the year :

(a) **Spring Seeding** — in Areas One and Two forage seeding should be early to take full advantage of spring moisture. Throughout Areas Three and Four spring seeding of forage is most successful, but should not be considered later than mid-June.

(b) **Early Fall Seeding** — in Area One and the southern half of Areas Two and Three early fall seeding is particularly suitable for all forage crops except sweet clover. It is hazardous during severe grasshopper outbreaks and should not extend beyond September 15. Where used in Central Alberta, early fall seeding should be completed by August 15.

(c) **Late Fall Seeding** — (Just before freeze-up) is useful for placing seed in the soil for spring germination. This method is mostly used for seeding grass in the dry areas and areas subject to spring flooding.

SEEDING

Shallow seeding is essential. The grain drill is satisfactory and special adaptations are available to improve its use. One of the most useful is the flange for the discs to prevent seeding too deep. The main drill box can be used if a filler, such as cracked wheat, is mixed with the seed to maintain constant flow. Broadcasting should only be done where it is impossible to use the drill. Forage seeders are available.

SUGGESTED MIXTURES OF GRASSES AND LEGUMES FOR PASTURE

	Mixture	lb. seed per acre	Adaptation
1.	Rambler, Beaver or Ladak alfalfa	2 - 3	For all but drier parts of the province.
	Carlton bromegrass	6	
	Boreal or Olds creeping red fescue	2 - 3	
2.	Rambler, Beaver or Ladak alfalfa	3	Areas Two and Three.
	Carlton bromegrass	8	
3.	Rambler, Beaver or Ladak alfalfa	3	Areas Two and Three.
	Summit or Nordan crested wheatgrass	3	
	Carlton bromegrass	6	
4.	Rambler alfalfa	2	Area Two.
	Sawki Russian wild ryegrass, Summit or Nordan crested wheatgrass	6	
5.	Nordan or Summit crested wheatgrass or Sawki Russian wild ryegrass	6	Driest areas.
	Rambler alfalfa	1	
6.	Carlton bromegrass	12	Short-term pasture under irrigation.
	Beaver, Vernal or Ladak alfalfa	2	
7.	Carlton bromegrass	7	Long-term pasture under irrigation.
	Boreal or Olds creeping red fescue	4	
	Chinook orchardgrass	7	
	White clover	2	

SUGGESTED MIXTURES OF GRASSES AND LEGUMES FOR PASTURE OR HAY

1.	No. 1 pasture mixture	—	For all but drier parts of the province.
2.	Rambler, Beaver or Ladak alfalfa	3	For Areas Two and Three where moisture conditions are variable.
	Carlton bromegrass	5	
	Summit or Nordan crested wheatgrass	3	
3.	Aurora alsike clover	2	Suited to wet locations subject to flooding.
	Frontier reed canarygrass	5	
	Climax timothy	1	
4.	Aurora alsike clover	2	For acid soils subject to flooding.
	Red top	5	

SUGGESTED MIXTURES OF GRASSES AND LEGUMES FOR HAY

1.	Beaver or Ladak alfalfa	5	Recommended for same area as No. 1 pasture mixture.
	Carlton bromegrass	6	
2.	Beaver, Ladak or Rambler alfalfa	5	For drier parts of Areas Two and Three.
	Summit or Nordan crested wheatgrass	6	
3.	Beaver, Ladak or Rambler alfalfa	3	For Areas Two and Three where moisture conditions are variable.
	Carlton bromegrass	5	
	Summit or Nordan crested wheatgrass	3	
4.	Beaver or Ladak alfalfa	5	Areas of plentiful moisture.
	Climax timothy	3	
5.	Altaswede red clover	5	Grey wooded or black soil areas of plentiful moisture.
	Carlton bromegrass	6	
6.	Altaswede red clover	5	As mixture No. 5.
	Climax timothy	3	
7.	Aurora alsike clover	4	Wet locations subject to flooding.
	Climax timothy	3	
8.	Aurora alsike clover	4	Areas subject to prolonged flooding.
	Frontier reed canarygrass	3	
	Climax timothy	1	
9.	Beaver, Ladak or Vernal alfalfa alone	—	Preferred hay crop in irrigated areas.

RECOMMENDED LEGUMES FOR ALBERTA

Kind	Area	Moisture Conditions	Varieties	Main Uses	REMARKS :
Alfalfa	1, 2, 3, 4, Ir.	Moderate to moist	Beaver	Hay	Hardy, wilt resistant.
		Moderate to moist	Ladak	Hay	Hardy, partially wilt resistant.
		Moderate to moist	Vernal	Hay	Mod. hardy, mod. wilt resistant.
		Dry to moist	Rambler	Pasture and hay	Hardy, wilt susceptible.
		Dry to moist	Roamer	Pasture and hay	Hardy, wilt resistant.
White clover	Ir.	Moist		Pasture	Palatable, low yield.
Ladino white clover	Ir.	Moist	Merit	Pasture	Palatable, high yield, mod. hardy.
			Pilgrim	Pasture	Palatable, high yield, mod. hardy.
Red clover	3, 4, Ir.	Moist	Altaswede	Hay and pasture	Suitable for short rotations.
Alsike clover	3, 4, Ir.	Moist	Aurora	Hay and pasture	Adapted to wet grass.
Sweet clover (white)	1, 2, 3, 4, Ir.	Dry to moist	Arctic	Hay, pasture, green manure	High yield, coarse.
Sweet clover (yellow)	1, 2, 3, 4, Ir.	Dry to moist	Erector	Hay, pasture, green manure	Early, high yielding.

RECOMMENDED GRASSES FOR ALBERTA

Kind	Areas	Moisture Conditions	Varieties	Main Uses	Best time to graze Sp.	Su.	Fall	Winter	REMARKS :
Bromegrass	2, 3, 4, Ir.	Moderate moisture	Carlton	Hay, pasture, seed	x	x			Most widely adapted grass in Alberta.
Crested wheatgrass	1, 2, 3	Dry to moist	Summit	Hay, pasture	x		x		Excellent dry land grass — easy to establish.
			Nordan	Hay, pasture	x		x		
			Fairway	Lawns & roadways					
Creeping red fescue	2, 3, 4, Ir.	Moderate moisture	Boreal	Pasture, lawns	x	x	x	x	Best cultivate pasture grass for foothills area.
			Olds	Pasture, lawns	x	x	x	x	
Intermediate wheatgrass	2, 3, 4, Ir.	Moderate moisture	Chief	Hay, pasture	x	x	x		Easy to establish.
Pubescent wheatgrass	2, 3, 4, Ir.	Moderate moisture	Greenleaf	Hay, pasture erosion control	x	x	x		Strong seedling vigor, easy to establish.
Orchardgrass	2, 3, 4, Ir.	Moderate moisture	Chinook	Pasture	x	x	x	x	Most productive irrigated pasture grass.
Russian wild ryegrass	1, 2, 3	Dry to mod. moisture	Sawki	Pasture	x	x	x	x	High protein, hard to establish.
Slender wheatgrass	2, 3, 4	Moderate moisture	Primar	Hay and pasture	x	x	x		Mod. alkali tolerance.
Tall wheatgrass	2, 3, 4, Ir.	Moderate moisture	Orbit	Hay and pasture	x	x	x		Most alkali tolerant grass, withstands wet conditions.
Tall fescue	2, Ir.	Moderate moisture	Alta	Hay and pasture	x	x	x		Mod. alkali tolerance.
Timothy	3, 4	Moist	Climax	Hay and pasture	x	x			Thrives with good moisture.
Reed canarygrass	2, 3, 4, Ir.	Moist to wet	Frontier	Hay, pasture	x		x		Wet and mod. alkali conditions. Most tolerant to flooding.
Red Top	3, 4 Ir.	Moist to wet		Hay, pasture	x		x		Withstands flooding, shortlived.
Bluegrass	3, 4 Ir.	Moist	Merion - Kentucky	Lawns, seed Lawns					

PASTURES

The following principles of pasture management are suggested to obtain maximum production.

Establish Forage

1. During the seedling year, effort should be made to provide most favourable conditions for the establishment of the grass and legume. This can be done by clipping weeds to reduce competition. Where a companion crop is used, it should be removed as early as possible for the same reason. Where growth warrants, pasture plantings may be grazed late the first year if they are not overgrazed or animals left on wet fields to cause damage by trampling.

No Early Grazing

2. Do not graze too early — always allow the forage growth to reach a minimum of four inches before turning stock in to graze.

Rotational Grazing

3. Controlled rotational grazing using three or four fields provides the stand with periods of rest and recovery. The plants are grazed at their most palatable and nutritious stage of growth. As the stock are moved off, the pasture's ungrazed growth should be clipped and droppings spread by harrowing.

Surplus Growth

4. Pastures are most productive in June and surplus growth at this time of year should be harvested for hay or silage.

Legume Valuable

5. The value of a legume, such as clover or alfalfa, in stimulating pasture growth cannot be over-emphasized. The proportion of legume to grass can be regulated by careful use of commercial fertilizers. Nitrogen fertilizers stimulate grasses while phosphates promote legume growth.

Irrigated Pasture

6. On irrigated pastures, rotational grazing is essential. Maximum production is obtained by the quick removal of top growth and allowing at least three weeks for recovery before regrazing. Rotational grazing with a minimum of four fields is recommended.

Fields should be of a size that can be grazed off in a very few days. Following each grazing, the field should be cut with a mower to remove excess growth, harrowed to break up droppings, and irrigated. Excess pasture in the spring should be harvested for hay or silage.

Annual Pasture

Annual pasture crops are useful for supplementing perennial pastures and for intensively grazed areas such as paddocks, hog pastures and poultry runs.

1. Oats, or oats and fall rye in mixture, are favored for annual pasture. These crops should be sown about mid-June so as to have them in the boot stage and ready to pasture by early August when other pastures are past their peak.

2. Cover crops, originally used to prevent soil drifting in Southern Alberta, are now grown extensively for fall finishing of beef cattle on the farm land adjoining the foothills areas. Oats seeded at a rate of a bushel per acre during the last half of July are the most satisfactory cover crop. Cattle are moved in when the oats are from 12 to 15 inches high.

3. Pasture rape — Dwarf Essex or Gartons' Early Giant at four to five pounds per acre under-seeded in wheat provides fall pasture for sheep or hogs after the grain is harvested.

HAY

Quality

Hay quality is generally determined by leafiness, color, palatability and the amount of foreign material. As most of the nutritive value of the plant is contained in the leaves, leafiness is the most important single factor. Hay in which the leaves have been lost during harvesting is of relatively low quality.

A bright green color is associated with high feeding value. There is usually a correlation between the green color and the quantity of carotene or vitamin A in the hay. Visual observation of hay can only be considered a rough guide to

its quality. A laboratory test should be obtained to determine feeding value. Such information is essential to an intelligent approach to feeding practices.

Weeds and foreign material such as dry stems of the previous year's growth and stubble lower the feeding value.

The following management procedures are offered for the production of high quality hay.

Good stands are the best insurance against weeds or foreign material in the hay crop. Stands seeded at the recommended rates on clean land will produce the greatest amount of stem and leaf growth. Over thick stands will become very fine stemmed and yield much less. Irrigation, fertilization and cutting practices should be complete and uniform so that the whole crop will be at the same stage of growth and maturity at the time of cutting.

Hay Management

Time of cutting varies with the crop but is determined by the stage of growth. With alfalfa, the best time is the 10 per cent bloom stage combining high yield with high protein content. This is more important than higher tonnage of lower quality.

Grasses vary, but in general they should be cut between the time of heading and full bloom. Beyond the full bloom stage much of the protein content of the leaves is transferred to both the roots and the seed with a consequent decrease in the value of the hay.

Curing and Handling — Rapid curing is the key to top quality hay. Alfalfa at the time of cutting usually contains 70 to 80 per cent moisture and about 12 per cent when thoroughly air dried. It can be safely stacked at about 25 per cent moisture, and baled at about 20 per cent moisture. Handling when dry results in a shedding and loss of leaves so that haying operations should be carried out while the crop is still tough. Cutting in excess of the amount that can be raked and baled the following day means that some of the hay will lie too long in the field and will be either too bleached or too dry to handle. At the same time there is a risk of the cut crop being caught by adverse weather.

The use of hay conditioners will speed up curing of the hay. General drying time will be cut in half.

Excessive handling is the main cause of loss of leaf between cutting and marketing. Hay should be handled as little as possible and while it is still tough. First drying should be done in the windrow rather than in the swath. This can be done by cutting with a swather or raking directly behind the mower.

Storing — Most hay is stored either in the loose stack or field baled and stacked. Loose stacked hay can go into the stack slightly more moist than the baled.

In general the sweep rake and stack are used for rapid stacking. Baling directly from the windrow is now common practice in Alberta. Here, sufficient attention should be given to moisture content. The baling of over-dry hay results in excessive loss of leaves and baling of under-cured hay may result in heating and moulding.

Prompt stacking and proper capping of stacks, whether of loose or baled hay, is a safeguard against weather damage. To further retain quality, some producers use open hay sheds and plastic or canvas covers.

Artificial Dehydration — Artificial dehydration is limited to production of dehydrated alfalfa for high quality and high protein. The alfalfa is harvested in the pre-bud stage and hauled to the dehydrator where it is rapidly dried and converted into alfalfa meal. Distance from field to dehydrator is a limitation since quality of the produce and efficiency of the operation are reduced by long hauls.

SILAGE

Ensiling is an excellent way of preserving the feed value of a forage crop when it is not possible to make good hay. Silage has other advantages as well, such as :

(1) Unpalatable components of a feed are made more palatable.
(2) The fire hazard is eliminated.
(3) Many weed seeds are killed.
(4) Leaves are more easily retained.
(5) Carotene content is usually high.

Some disadvantages of silage are:

(1) It is bulky to handle both in preserving and feeding.

(2) More exacting storage is necessary than that required for hay.

Silage has been made from many different crops such as corn, cereals, grasses, alfalfa, sweet clover, sunflowers, beet tops and pea vines. The important consideration for conventional ensiling methods is that the moisture content of the crop be between 65 and 70 per cent. With too little moisture, moulds are likely to develop. With too much moisture there is an excessive loss of nutrients in the liquid that runs from the bottom of a silo. Crops in the hay stage have about the right amount of moisture, with a few exceptions. Grasses growing under very dry conditions may be too dry. Immature forage growing on irrigated land could be moist enough to benefit from a short period of wilting in the windrow. If free liquid can barely be squeezed by hand from the chopped material, the moisture content will be about right.

Some adjustment in the moisture content of the crops is possible while the silo is being filled. Water can be added to crops that have become too dry, although the forage must still have some succulence of its own. Wet crops will benefit from the addition of a drier feed, such as hay or grain that will absorb some of the excess moisture.

The ensiling process depends on the presence of carbohydrates for good fermentation. Crops low in carbohydrates such as legumes, and to some extent grasses, will make better silage if a conditioner is added. Ground barley or beet tops at 150 pounds per ton of silage or molasses at 80 pounds per ton are good conditioners. Well-matured corn does not require a conditioner.

The basic objective in silage making is to exclude air from the fermenting fodder. Anything that will do this is worth considering. Packing is a very effective means of excluding air and is quite sufficient if well done. There is no possibility of too much packing, only too little.

In tower silos the bottom ⅔ is packed by the weight of the material above and only the upper portion requires special attention. Air tight silos are available and require no packing at all, but they are rather costly which limits their popularity. The more common trench or bunker type silos are usually packed by driving a tractor over the material as the silo is being filled. Farmers continue packing for three or four days after filling or until no further settling occurs.

It is advisable to deposit a two-foot layer of unpacked material on the floor of the silo a day or two before the main operation is begun. After this layer has dried a little and begun to heat, it can be packed thoroughly and will then act as an absorbent for liquid that seeps down from the silage above. In packing the trench or bunker silos special attention should be payed to the edges to prevent the formation of air pockets. It is particularly important to avoid drying on the sides exposed to the wind and sun. A final covering of the top with any convenient material that will reduce air exposure will hold spoilage to a minimum. Hay, straw, plastic or tar paper sheets, weeds, germinating cereals, soil and many other things have been used for this purpose.

The shape of the silo should be such that at least four inches of silage will be removed from the exposed surface each day of the feeding period. Well packed silage weighs 35 to 45 pounds per cubic foot. If the daily consumption can be predicted, the best size and shape of silo can be calculated. With a bunker silo it is convenient to self-feed cattle by hanging a gate from a movable pole suspended by the two walls. The gate will be pushed ahead by the animals as they eat, although some restrictions will be necessary at times to force cleaning up of the less excessible feed. The silo should have a minimum width of one foot of face for every three mature animals being self-fed.

Temporary Silos

Emergency means of ensiling a crop are often useful, but they should not become regular practice. The annual cost of a temporary silo might be low, but over a period of years it could well exceed constructed storage. Also, the amount of spoilage is often very high in hastily constructed silos. Although the financial loss might not be apparent, it is very real.

Temporary walls can be constructed of bales of straw or hay; snow fence lined with tar paper, plastic sheeting or bales; old buildings or anything else

convenient. If no wall is available, the forage can be deposited in a mound, over which a tractor can be driven in many different directions for packing. It should be noted that spoilage can exceed 50 per cent in this method. Spoilage will be minimized by covering the silage tightly with a plastic sheet and removing the air underneath, but this again increases cost.

CROPS

Some of the more important silage crops and special considerations for them are :

1. **Oats.** Seed about 20 per cent heavier than for grain and harvest when in the milk stage. The late varieties will give the highest yields. The addition of about 15 per cent of an early maturing barley will improve the quality of the silage.

2. **Alfalfa.** Cut at the 10 per cent bloom stage or later and add a grain conditioner.

3. **Corn.** Harvest when the grain is well-dented and firm but the leaves are still green. Use an early hybrid. Corn has a good potential in the irrigated area of south-eastern Alberta but its usefulness is questionable in other parts of the province. Under irrigation, 20,000 plants per acre will give a good yield, well balanced between stock and ear. About ¼ bushel of seed per acre will be required.

4. **Spring Pastures.** If more succulent forage is available than can be utilized in spring, it can be preserved very effectively as silage. Usually no preservative is necessary although chopped grain may improve it.

5. **Sorghum-Sudan Grass Hybrids.** These hybrids are annuals and can be used as hay, pasture, or silage. They should be planted in early June. They require warm weather for good growth, but seem to be more widely adapted than corn. They should not be used until the plants are at least 18 inches high, because of the danger of Prussic acid poisoning from the fresh growth.

SPOILAGE PROBLEMS AND CAUSES

Losses due to spoilage can be costly, especially if they represent a deterioration or loss of the entire winter roughage supply. The danger of spoilage should not, however, deter the beginner from attempting to make silage. The problems are relatively simple and easy to avoid. There are four main types of spoilage which can occur and each indicates some error in making the silage.

Mouldy silage

Moulds require oxygen in order to multiply. Where moulds occur in silage not enough packing is indicated. If the silage has not been uniformly spread, resulting in uneven packing, pockets of mouldy material may occur.

A little mould will not ruin an entire store of silage but it will reduce palatability and therefore should be avoided. Mouldy sweet clover silage may be dangerous and should not be fed.

Overheated silage

Silage that has been overheated can be recognized by its dark-brown to black color. Associated with the dark color will be a "tobacco" odor.

Overheating is caused by insufficient packing. By leaving too much air in the silage the start of spontaneous combustion has been permitted. Overheating often occurs when the silage is too dry—because dry silage is more difficult to pack thoroughly.

Two methods of prevention are suggested. Ensile at a higher moisture level or increase the amount of packing. From the standpoint of feeding value, as explained elsewhere in this bulletin, increasing packing is preferred.

Overheated silage is often relished by livestock. The feeding value, however, will be lower. Heat is a form of energy, therefore there has been a loss of energy in heated silage. Moreover, most, if not all, carotene will have been destroyed.

Rotten silage

This condition is the result of a combination of too much moisture and too much air. Leaky caps or faulty structures which allow free moisture and air to enter the silage are the usual causes. Such material is unfit for feed.

To avoid this problem simply make sure the silo is properly capped so free moisture cannot enter the silage. See that drainage around the silo leads moisture away from rather than into the silo.

Slimy silage

Often associated with the sliminess is a dark green color and a putrid odor. This condition is the result of a lack of enough fermentable sugars to produce desirable acids. This problem is encountered more often with legume crops or mixtures high in legume content. Legumes are normally quite high in protein but relatively low in sugars and starches. With an inadequate supply of fermentable sugars, the microorganisms tend to break down the proteins to ammonia and butyric acid which produce a foul smell.

Wilting the crop will help prevent this situation. However, if the crop is predominantly legume, it is advisable to add some ground grain or molasses. Apart from assuring a proper fermentation, these additives are desirable from a nutritional standpoint.

NATIVE HAY AND PASTURE LAND

Native grasslands in Alberta vary with soil and climatic conditions. They are classified as:

1. Tall or fescue grassland.
2. Mixed.
3. Short.

The Fescue Grassland includes the black soil zone and parkland areas of south-western and central Alberta. It also occurs in the Cypress Hills of south-eastern Alberta. In fescue grassland, rough fescue is dominant with porcupine grass, wheatgrasses, oatgrasses, and June grasses also occurring. In the Porcupine Hills, Parry's oatgrass and Idaho fescue form an important part of the cover. Forbs and shrubs are common and may become serious range weeds under heavy use of the pasture. The more important range weeds include shrubby cinquefoil, western snowberry, and rose.

Fescue grassland is well supplied with stock water through springs and creeks. A major problem, because of the steeply rolling nature of much of the zone, is uniform distribution of grazing animals. Salting away from water will help. Poplar and willow growth provides stock shelter.

The Mixed Prairie and Short Grass Plains is the treeless prairie of the brown and dark brown soil zones in Alberta. A portion in extreme south-eastern Alberta is often referred to as the "Short Grass Plains" but differs from the remainder only in the relative abundance of individual species.

The main grasses are blue grama grass (dominant in the "Short Grass Plains"), spear grass, June grass, wheatgrasses and porcupine grasses. Common forbs include fringed sage, broomweed, crocus, and silver sage, while rose and hoary sage are the more important shrubs. When constantly over-grazed, blue grama grass and fringed sage dominate with an understory of club moss.

The Alberta Department of Lands assesses lease lands on their ability to produce beef. Consequently, the province is partitioned into zones in which the grazing rates range from 24 acres per head per year to 60 acres per head per year.

In general this is divided into equal acreage for summer grazing and winter feed. These rates are calculated to maintain an excellent vegetative cover under normal climatic conditions for the zone.

At Stavely, an excellent range and better than normal rainfall, the best rate of grazing for the past 10 years has been between 9 - 10 acres per head for a six-month grazing period.

While these established rates are general for the zone, the rate of grazing on the individual range is governed by the vegetative cover and the annual production.

The most common rule for grazing is to "'Use half — leave half". Fifty per cent carry-over allows for cover improvement and production increase.

Management of Native Range

If ranges are heavily grazed, the palatable plants are killed, and replaced by weedy, unpalatable, non-productive species that produce ideal breeding grounds for destructive insects. Over-grazed range land is subject to water erosion. It does not retain enough cover to catch and hold snow and loses moisture through run-off of summer rains.

Uniform grazing is often difficult since the natural tendency of cattle is to feed along coulee bottoms and around water holes. Water holes placed from one to 1½ miles apart will keep livestock scattered. Salt licks away from the watering places, and scattered shelters in treeless areas, also encourage best range use. Salt licks should be moved at intervals to prevent localized abuse of the vegetation. Knowledge of the range and of livestock habits can do much to secure uniform distribution of grazing.

The management of native hayland is a problem only in areas of good moisture. On the dry plains, haying is confined to depressions and other favorable locations and can be practised anytime the growth warrants. In the foothills, Cypress Hills, and similar areas, the general practice is to cut upland hay only in alternate years. Cutting more often results in damage to rough fescue partiicularly with a consequent drop-off in yield of hay.

When native grass hay is cut late in the season the feeding value may be reduced to the point where it is not much better than wheat straw.

FORAGE SEED PRODUCTION

Forage seed production is a specialized type of farming program. It requires an understanding of cultural principles and a thorough knowledge of seed standards and regulations as established by the Canadian Seed Growers' Association and the Canada Department of Agriculture.

Many forage crops are cross-pollinated. In addition, many crops have seeds similar in size and shape making separation difficult. Therefore, it is essential to have adequate isolation in order to produce pure seed. While most forage crops can be grown successfully throughout the province, seed production should be attempted only where this is assured.

Meticulous cleaning of all equipment is required to further prevent mixing or contamination of the seed crop.

Seed

Seed marketed under a variety name must be pedigreed (Certified grade or better). Seed producers should therefore use seed of at least one grade higher than Certified, that is Registered or Foundation. If no named varieties of a crop are available, only the best procurable Canada No. 1 seed should be used.

Choice of variety requires careful consideration. The selection should be one that will have popular demand to ensure sales and possibly better prices. Buyers of forage seeds are variety conscious and growers should be sensitive to their demands. Contract production of seeds of newly-licensed Canadian varieties and imported foreign varieties for specific markets may be worth consideration.

Seeding

Forage seed should be produced on clean land.

Row seeding usually results in higher yields than broadcast or close seeding but it has some cultural disadvantages. Extra labour is required to cultivate rows and swaths are harder to pick up. A satisfactory compromise is to plug every second drill hole so as to have rows 12 to 14 inches apart. Seed production in drier areas requires wider row spacing for maximum yields. (See previous section on "Seeding".)

With the introduction of foreign varieties, both tetraploid and diploid forms of the same crop are often available for seed production. Adequate isolation between these forms, as outlined in the rules and regulations for production of pedigreed seed, will assure the highest possible seed yield.

Hard-seeded legumes should be scarified and inoculated prior to seeding.

Pollination

All legume crops grown for seed in Alberta **must be cross-pollinated by bees.**

Sweet clover and alsike clover are the favorite food sources of honeybees. The acreage devoted to seed production of either crop should depend on the number of honeybees in the area. For good pollination, there should be at least one strong hive for every acre of alsike or sweet clover. As honeybees prefer sweet clover, alsike seed production will suffer if sweet clover is grown nearby.

Red clover is pollinated by bumblebees and honeybees. It must be isolated from sweet clover and alsike to obtain the services of honeybees and of the short-tongued bumblebees. It should be grown next to the bush or prairie in which bumblebees nest.

Because honeybees obtain little nectar from red clover, especially from the new tetraploid varieties, beekeepers do not want to place their colonies beside red clover fields without payment. If a red clover field is isolated from sweet clover and alsike, it will pay to hire the services of honeybees. Such payment should be based on the loss of surplus honey by the beekeeper and the gain in pounds of seed by the seed grower.

Alfalfa is pollinated by leaf-cutter bees and bumblebees. To obtain the services of wild leaf-cutter bees and bumblebees, the field must be taken to the bees. This is done by growing the alfalfa in long, narrow strips next to the bush or prairie on which the wild bees live. Also, the crop must be isolated from other legume seed crops. Acreages must be kept small, as there are seldom enough wild bees within flying range to pollinate more than 20 acres.

Where the climate is suitable for its propagation, the domesticated alfalfa leaf-cutter bee, **Megachile rotundata**, can be taken to the alfalfa field which can be of any size or shape. To date growers in the irrigated areas of the Lethbridge, Brooks, Medicine Hat triangle have had most success with this bee. A few growers from the central and northern areas of Alberta have reported success, but many have had none. The alfalfa leaf-cutter bee requires 70° F. temperatures to fly and needs over 300 hours with temperatures 70° or higher to complete its life cycle.

Fertilizers

Fertilizer use means better seed yields. (See sections on "Fertilizer", page 19.)

Rogueing

Rogueing is a must for high quality production. This means removal by hand of off-type plants and any weeds or other crops which may be difficult to clean out of the seed.

Harvesting

Straight combining of forage crops is generally not recommended since forage seed usually shatters readily. If this is the method chosen, it should be done before the crop is dead ripe. Some provision should be made for drying the seed before storage.

Swathing and pick-up is the most common method of harvesting, although binding and threshing is equally good. For combine or thresher settings, follow the instructions of the manufacturer.

Some important thumb rules in threshing are :

(1) Run the cylinder at the slowest speed that will remove the seeds from the heads. This will break fewer stems and leaves and make separation much easier.

(2) Never overload the machine.

(3) Rub-bar cylinders are usually preferred to the toothed type.

(4) Repair leaks that can result in heavy losses of seed.

(5) Clean the combine thoroughly before moving from one kind of crop to another. Admixtures can degrade seed.

Storing

Freshly-harvested seed is often high in moisture and is subject to heating which may destroy germination. Adequate drying is necessary before storing. If seed is to be stored in sacks for any length of time, some protection from mice must be provided. Fifty per cent wettable D.D.T. powder spread around the sacks so that the mice must walk on it will provide effective and economical protection. Storage must be dry and care must be taken to prevent snow or rain from reaching the sacks.

Cleaning

Cleaning forage seed is difficult and requires specialized equipment. Only rough cleaning to remove excess dockage should be attempted on the farm.

For final cleaning to highest possible grade, the seed can be shipped to one of the many commercial concerns operating efficient, well-equipped plants.

NOTE: More detailed information on diseases, insects, weeds, etc., which are important to the production of forage crops may be found in other sections of the Guide. See Index.

REFERENCES

	Publication No.	Agdex No.
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Hay and Pasture Crops for Alberta	63	120/20-1
Silage in Alberta	127-52	127-52
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Forage Crops for Irrigated Land in Southern Alberta	1132	120/20-2
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Growing Irrigated Crops in Southern Alberta	1152	135/70-1
Irrigated Pastures in Southern Alberta	1160	135/70
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Importing and Managing the Alfalfa Leaf Cutter Bee	1209	121-615

HORTICULTURE

INTRODUCTION

Horticulture, one of man's ancient arts, today involves the application of basic scientific principles in the production, preservation and marketing of fruits, vegetables and ornamental plants for food, comfort and beauty. It can provide personal pleasure and financial gain to both rural and urban dwellers. Based on demand and increasing knowledge, horticulture's place in the lives of Alberta residents is expanding rapidly.

SPECIAL NOTE

Proper varieties and good stock are particularly important for successful gardening in Alberta. Be sure you know the varieties adapted to your area. These varieties are listed in the "Alberta Horticultural Guide".

FARMSTEAD PLANNING

(a) Shelterbelts

Every Alberta farmer would benefit from a shelterbelt planted to give protection to the farmstead. Trees provide shelter for livestock and gardens, improve the appearance of the farmstead and add to the comfort of living. They will help to control soil erosion caused by wind and water. If the windbreak is properly located it will reduce the high cost of snow removal.

Farmstead Shelterbelts

An ideal farm shelterbelt is made up of a snow trap of low growing hedge material in the outside row. A fast-growing deciduous variety in the second, a slow-growing deciduous variety in the third row and conifers in the inside row. Two or more rows of each may be used if desired. The rows should be planted far enough apart so that power equipment may be used for weed control. There should be at least 100 feet between buildings and shelterbelts.

Field Windbreaks

These are planted to help control soil erosion caused by wind. They are single rows of trees planted 30 to 40 rods apart across the prevailing winds.

Roadside Windbreaks

These are planted 125 feet back from the property line. They will serve as a permanent snow fence.

General Information

(1) Summerfallow one year before planting.
(2) Fence to protect against livestock.
(3) Maintain clean cultivation both inside and outside the shelterbelt.
(4) Protect against fire damage.
(5) Do not plant evergreens in the same row as broadleaf trees.
(6) Do not prune shelterbelt trees except to remove dead or broken branches.
(7) Always prepare a definite and complete plan of the tree planting program before the work is started.

Sources of Material

For further information and to obtain trees for farm planting, see your district agriculturist or write to the Alberta Department of Agriculture, Plant Industry Division, Edmonton.

(b) Landscaping

Inside the shelterbelt is an area of from five to 10 acres depending upon whether the farmstead plan is developed for an irrigated farm or a non-irrigated farm. Within this area are two main divisions and a secondary division. These include the working area and the living area of the farmstead. The living area has the house, grounds, and the supplemental areas beside it.

The working area has a farm yard giving access to all the buildings necessary to the farm business. Back of and between the farm buildings, but with ready access, are pastures, machine yards, feedlots, grain storage areas, and hay yards. This area needs good access roads. The road going to the fields should not pass directly through the main shelterbelt.

The second area is the living area of the farmstead and the centre of interest is the home. Its location and distance from the main thoroughfare depends upon the direction it faces and on the topography of the surrounding area. Where prevailing winds are from the north-west, houses that face south or east gain the full protection of shelterbelts. Farm home grounds can be very plain and easily cared for, or progressively more fully developed, depending upon the interest and the time available for looking after this part of the farm program.

The first need is a good grass cover surrounding the home. This grassed area should have roadways and sidewalks. Cut the area up as little as possible. But still provide for the basic services and a generous parking area and turnabout for vehicles. Do not make the grassed areas so small that they cannot be looked after with power equipment.

Frame the house with large trees, one at each side of the house and one or more at the back of the house. The type of trees planted will influence the eventual appearance of a house. Tall, narrow, rectangular houses can be much improved by planting broad spreading trees. These are the most important trees, and should be planted at the earliest possible time in the landscaping program. The framing trees on the sides should be 20 to 40 feet beyond the boundary of the house and either slightly in front of or behind the building line.

Foundation shrubs, particularly at the corners and beside the entrance, tie the house into the surrounding lawn area and aid in accentuating the architectural effect. They should be carefully chosen, particularly for their optimum shape and heighth.

The corner plantings should not reach more than two-thirds of the way to the eave on low houses, or beyond the half-way mark of first storey windows. Other foundation plantings should never grow up to interfere with views from windows or to obscure passageways.

Other considerations in choosing the foundation shrubs are — their seasonal colors — bark, foliage, flower, and fruit. Leaf texture and the blending or contrasting effect they have against the surface materials of the home should be considered. Flowers, annuals or perennials, in beds or planters, may supplement the foundation planting.

Screen plantings of small trees or tall shrubs between the house and the working area, the garden or orchard area, and across the path of secondary wind patterns, are an advantage. Boulevard plantings of large trees, between the house and main road, should be at least 100 feet back of the property line, well-spaced and pruned up so that vision is possible, underneath them to the road. Similar plantings along the driveway coming into the farmstead must be given some thought because they can form snow traps if not suitably located. Large trees, planted wherever possible throughout the enclosed farmstead, help to hold the wind and prevent its return to normal velocities over a much wider area.

The next steps in farmstead planning are related to what you see from inside the house. This step should be thought out by being within the house. Good views should be framed, unsightly views should be screened and centers of interest should have, on the vision line, interesting plantings of shrubs, flowers, gates, sidewalks, or garden ornaments. Careful planning and planting of well chosen ornamentals can give these views interest and color throughout the year. Next to the framing trees, these plantings can add the most to farm living.

The area between the house and shelterbelt, which should have a distance of 100 and preferably 200 feet, is normally devoted to garden and orchard planting. This is not the area that produces the winter supply of vegetables. It supports, basically, the kitchen garden, with ready access to fresh vegetables for a summer supply. This area should have planted in it asparagus, rhubarb, raspberries, gooseberries, currants, and 10 to 15 of the better fruit trees. The planting in this area should be thought out well in advance so that cultivation can be accomplished with farm equipment.

Other factors of importance when working out your farmstead plan are access to fuel supply, water supply, protection of sewage disposal areas, access to the clothesline and views of the working area from some of the windows in

the home. Be sure that adequate drainage is given consideration. Do not plant large trees under power lines, and make generous provisions for parking and turning cars.

LAWNS

When considering farm lawns it is not uncommon to think of two types, the small well-kept area around the house, and the larger, rougher area away from the house. In spite of difference in appearance, there is really little justification for sowing a separate type of seed mixture for each. The difference can and should lie in management. When supplementary water is available, mixtures containing Kentucky Bluegrass and Creeping Red Fescue will provide the best lawn turf. These grasses are generally mixed on the basis of equal parts by weight, and sown at the rate of four pounds per 1,000 square feet. Should supplementary water not be available "Fairway" or "Stream-bank" wheat grass may be more satisfactory. Either can be mown to two to 2½ inches at which height they make acceptable turf.

Before starting a lawn, it should be understood that the product will be no better than the soil on which it is growing. The top soil of the seedbed must be at least six inches deep, of good texture and be free from extraneous materials such as subsoil-clay, stones or builders' material. If the soil is very heavy, then the addition and incorporation of 10 to 15 per cent organic matter is advisable.

Established lawns will not tolerate mowing at a height of less than one and one-half inches. It is not necessary to remove clippings unless they are very heavy. A lawn will respond favourably to regular mowing.

ORNAMENTALS

(a) Trees and Shrubs

Care of Nursery Stock Before Planting — On receipt of planting material, the packages should be opened and the plants moistened and then transplanted. Avoid unnecessary exposure to wind and sun. If the trees or shrubs cannot be planted immediately they should be "heeled in", that is placed with their roots in a trench, preferably on the north side of a building or shelterbelt. In this position the roots are covered with moist soil.

Planting Suggestions — In Alberta, the growing season is shorter than in many parts of Canada where nursery stock is grown. Therefore, selecting plant materials that are known to be hardy for the region is of extreme importance. If a tree or shrub is not capable of maturing its wood and/or root system within the Alberta growing season, it will likely be severely damaged or killed by winter conditions. The Alberta Horticultural Guide lists only species and varieties that have proven hardy in this region. Vigorous, well matured planting material that is received in a dormant state will withstand transplanting best. It also is more resistant to pests and diseases.

Autumn planted materials are often subject to winter injury, so in Alberta, spring planting is preferred for most trees and shrubs. If trees are planted during the fall, they should have ample water until freeze-up. When spring planting is planned, deep plowing the previous fall leaving the soil rough over winter will be beneficial, particularly if the soil is at all heavy.

Planting Holes — It is advisable to lay out and stake the planting area prior to digging the planting holes. Size of hole depends upon the size of the tree and its root system. The hole should be large enough to receive the roots without crowding. The top-soil and the sub-soil removed from the hole should be kept separate. The moisture holding capacity of the soil can be improved by mixing organic matter with the top-soil.

Setting the Trees — Trim any broken or ragged roots with a sharp knife or pruning shears. Set the roots in their normal position. Plant the trees about two inches deeper than they stood in the nursery row. In open, windy, locations, trees may be slightly inclined towards the prevailing wind. Use top-soil for backfilling the holes. The soil should be packed firmly around the roots prior to watering. Planting failures are often due to not enough packing of the soil at planting time. A depression or basin approximately one inch deep should be left around the tree for watering.

Water newly planted-trees well. To avoid excess evaporation, keep the top inch of soil loose or use a mulch of peat, lawn clippings, or evergreen boughs.

Feeding — Established trees, five years of age and older, may be supplied with 1½ to two pounds of 5-10-5 fertilizer per inch of tree diameter. This diameter is measured at three feet above the ground.

To apply fertilizer, punch holes 15 inches deep and 1½ inches in diameter 18 inchs apart on the circumference of two circles each having the same centre. The circumference of the outer circle should be along the "drip line" of the tree where the branches end. The inner circle should be half way between the tree trunk and the outer circle.

Fill the holes with fertilizer and water well.

Pests and Diseases — See Plant Diseases and Crop Insects.

PRUNING

Deciduous Trees — Pruning is an art that is often overpractised. Trees in spacious surroundings require the minimum of pruning to remove dead and injured wood; to prevent weak and narrow crotches; to distribute the number of main branches on the trunk and to remove crossing and interfering branches. The best season for pruning is early spring. Detailed information is available in the Alberta Department of Agriculture's "Pruning Manual".

When pruning, cut the branches close to their origin. Do not leave stubs. They do not heal readily, making them subject to infection. When large limbs are to be removed, carry out the operation in three steps.

First, make a deep cut on the lower side of the branch at 10 inches from the trunk. Then, make a second cut on the upper side of the limb slightly closer to the trunk. This will eliminate the major portion of the branch. After this, the stub can be sawn off flush with the trunk.

Shrubs — Most shrubs are pruned early in the spring before the buds break. But spring flowering shrubs, such as lilac and double-flowering plum, are pruned immediately after flowering. Remove only unwanted branches at the base of the plant. Heading-back of branches is used at planting time and when necessary to restore the shape of a plant.

Evergreens — These are slow growers and pruning should be done with extreme care. Mugo pine must be pruned each year to maintain its dwarf habit. The terminal spring growth should be headed back two-thirds just as the buds have attained full elongation. No additional pruning should be attempted. Fir and spruce can be handled in a similar way, but do not remove lower branches of these trees.

(b) **Perennial Flowers**

The term perennial flowers usually means herbaceous flowering plants which kill back to the ground level each winter. But perennials have renewed growth from the roots or other underground structures each spring. The long list of perennial flower species which are hardy in Alberta includes plants only a few inches high to ones over three feet in height. The varieties within species are few and so the color range is limited. However, a complete range of colors is available among the different species.

Perennials are particularly useful in rock gardens and border plannings. A rock garden using mainly dwarf and alpine species or a perennial border using a variety of species from dwarf to tall can be a joy to behold from early spring until winter.

Many perennials can be started from seed. Once established, they are easily propagated by stem or root cuttings or division of well-developed crowns. Varieties which do not come true from seed are propagated entirely by vegetative means.

Most perennials require little protection during the winter months. A covering of evergreen boughs or a six-inch layer of coarse long straw which tends to collect snow is often beneficial and recommended for central Alberta. Mulches of grass clippings, wet leaves, short straw or fine-particled peat can lead to suffocation of the plant roots and are not recommended for winter protection. Some perennials which are not hardy can be successfully grown in Alberta if

the underground storage organs (fleshy roots, corms) are dug up and stored indoors in a cool place over winter. Such plants include dahlia, tuberous begonia, and gladiolus. The geranium is a special case in which the entire plant may be stored indoors. (For details see the Alberta Horicultural Guide.)

(c) **Annual Flowers**

Annual flowers can be started from seed, will bloom during the summer and die at the end of the season. The range in flower color is tremendous among the long list of varieties which can be grown. There is even a wide range of colors among varieties within a given kind of annual flower, for example, snapdragon or petunia. Annuals also vary in size from dwarf types only a few inches high to tall types over 18 inches in height.

Annual flowers are useful ornamentals in providing colorful displays throughout the summer season. They are usually most effective in mass plantings in beds or borders rather than as specimen plants. Long stemmed varieties are useful as cut flowers. Dwarf varieties are effective in rock gardens or as foreground or edging plants for a perennial flower bed or shrub border. Annuals are also useful as replacements for early spring flowering bulbs or as fillers in perennial flower borders.

The time interval from seeding date until blooms develop varies with kinds and varieties. The time interval varies from approximately 60 days for such plants as zinnia and marigold to over 110 days for lobelia and double petunia. Because of the danger of late spring frosts in most parts of Alberta, it is unwise to start annual flowers outside before about mid-May. Therefore, it is advisable to start all annuals indoors or in a greenhouse to ensure full bloom outdoors for as much of the summer as possible. It is best to wait until all danger of frost is past before transplanting annual flowers outdoors.

(d) **House Plants**

Many of our common house plants require special treatment to keep them at their best. In general, however, most of the flowering varieties perform best with the maximum light conditions available in the house. African violet is a notable exception. Most plants do best indoors by a sunny window. Foliage plants, however, are best in indirect light.

Some foliage plants such as Sansevieria and Chinese Evergreen can be maintained satisfactorily under poor light conditions in a dark corner or hallway.

For all potted plants, a soil mixture of loam, peat and sand should be used to obtain a media through which air and water can freely circulate. Good drainage must also be provided. Regular applications of a complete fertilizer to established plants will keep the plants vigorous and encourage growth. Periodic leaching (drenching the growing medium with water) once or twice a year will prevent the build up of soluble minerals in the soil mixture.

The most common problem with house plants is yellowing and dropping of lower leaves followed by wilting and sometimes eventual death. In most instances these symptoms are brought on by improper watering. This results in too little soil moisture, too much soil moisture or a build up of soluble salts.

A good rule to follow in watering potted plants is to add enough water to thoroughly saturate all the soil. Any excess of water should be drained away. Rewatering should be done when the surface of the soil begins to dry and the soft ball of soil shrinks away slightly from the edge of the pot. The frequency of watering will vary with the kind of plant, its size in relation to the size of the pot and the relative humidity of the air.

FRUITS

(a) **Tree Fruits**

Details of variety recommendations for the eight horticultural zones will be found in the Alberta Horticultural Guide. The success or failure of tree fruits in a particular location will depend upon local factors which will vary within a zone as well as between zones.

Site

The most desirable site for the farm orchard is a well-sheltered location with a slight slope to the east or north. Shelter is essential to prevent winds from causing excessive drying of the soil and plant tissues. Shelters also trap snow for moisture and winter protection, and provide an atmosphere suitable for insect activity essential for pollinization. A slight slope is desirable to provide air drainage to prevent frost pockets and is easy to irrigate without danger of erosion. Steep slopes and rolling land should be avoided. In dry areas, the orchard should be located close to a dug-out or other water supply.

Planting

Only recommended varieties should be planted at first and others as experience dictates. At least two varieties of a particular kind of fruit must be grown to ensure adequate cross pollination. The spacing of trees will vary somewhat with the kind of fruit and available cultivation equipment. Twenty feet between trees and rows is recommended for apples and crabapples and 15 feet for other tree fruits.

For planting and early care procedures refer to notes on this subject for trees and shrubs in the ornamentals section.

Pruning

Careful pruning procedures should be adhered to for the ultimate success of the plantation. On planting a one-year-old apple tree, the whip should be headed-back to a height of about 15 inches with a terminal bud on the windward side. The main trunk of a well-established second-year-old tree is again cut back leaving a terminal bud on the leeward side. The future scaffold limbs must be headed-back to promote spreading. The location of the new terminal bud will determine the direction of the new shoot.

During the second year, the leeward side bud will develop into a new leader whereas the next lower bud will yield a shoot which is growing away from the main stem. Pruning of a three-year-old tree consists of heading-back the new leader and the lower shoot. Side branches are cut back and those with narrow crotches are removed.

Crotches are considered narrow when the angle is less than 45 degrees. During later years, a main leader developing in the windward direction is of importance together with six to eight vigorous branches six to 12 inches apart distributed around the trunk. Heavy pruning will delay fruit bearing. Therefore, later pruning has to be carried out very carefully, improving particularly the secondary framework of the tree.

The pruning of plums and apricots should be light. The main leader should not be headed-back within the first three years. Existing side branches of two-year-old trees are to be developed as scaffolds and are headed-back to approximately 15 inches.

Sandcherries and cherryplum hybrids bear best on young wood and should be pruned heavily every three years to promote vigorous new whips and to maintain a low bush form.

Treat wounds over 1½ inches in diameter with a commercial water solvent asphalt compound. A Bordeaux paste made from linseed oil and Boreaux powder might be used instead. Apply paste to the cut area without spreading over the adjoining bark.

Hardiness

Those varieties listed as being satisfactory for the various zones have survived in test locations for several years and are considered to be hardy. Abnormal conditions such as severe late frosts, extreme or prolonged low winter temperatures, alternate freezing and thawing which often occurs in the Chinook areas, prolonged drought and severe drying winds, may contribute to injury or death of flower or leaf buds and plant tissues of even the hardiest varieties. Disease and insect injury during the growing season may so weaken trees that they become more subject to injury from some other factor.

Adequate shelter, irrigation in late fall when the trees are dormant, timely insect and disease control, eliminating grass and weed competition are all factors to consider to maintain a healthy plantation.

Pests

Mice and rabbits cause much damage to fruit trees. Preventative measures for rabbits include fencing the orchard or individual trees with wire mesh and protecting the trunk and lower branches with a repellent. Protecting the trunk with window screening or aluminum foil, maintaining clean cultivation to eliminate nesting areas and using repellents will do much to control mice.

Fireblight is the most destructive disease affecting apples, crabapples and pears. For control measures see page 107.

(b) **Small Fruits**

Many of the small fruits including strawberries, gooseberries, cranberries, raspberries, red and black currants, saskatoons and several others are native over most of Alberta. Many cultivated varieties of these fruits are quite hardy in even the extreme north if given a suitable site and proper culture.

For best results, the small garden should be on a well-drained, but not dry, deep, sandy loam soil. It should be sheltered from prevailing winds. However, with proper preparation and care most soils will grow satisfactory crops of small fruits.

To reduce winter injury, allow the plants to harden-off in late summer and early fall by withholding irrigation. Just before freeze-up give a thorough watering. Most of the small fruits will require no further winter care.

In areas where snowfall does not occur before severe frost and the snowfall does not remain all winter, strawberries should be mulched and raspberries laid down. A cover crop of barley sown in August will help to hold the snow. This will give added winter protection and slow the start of growth. Care must be taken when using cover crops to protect against mice.

Pruning should remove only weak, crossing-over and old branches which have passed the best producing age. The best producing age of the branches varies with the fruit. Reference should be made to the directions for each crop.

There are not many pests attacking small fruits. However, the spider mites, currant fruit flies and aphids can cause damage. These are described in the section on crop insects.

VEGETABLES

General — Choose a level area not subject to late frosts. An application of 12 to 15 tons per acre of well rotted manure would be advantageous.

The Soil — Very light or heavy soils are to be avoided whenever possible. They may be modified by good garden practices. Practices include plowing under granulated peat, well-rotted manure or green manure crops such as oats, rye or sweet clover.

Fertilizers — Fertility is maintained by the addition of well-rotted manures, vegetable refuse and straw (free of weeds and disease), commercial fertilizers, and by conserving the fertility already present in the soil. For most Alberta gardens, additional phosphorus should be added to supplement the small amounts that are present in animal manures. Superphosphate at 200 - 300 pounds per acre every two years should be ample. A fertilizer such as ammonium phosphate 11-48-0 may replace the manure and superphosphate applications when applied at 100 to 200 pounds per acre every two years.

Soil Testing — Results of soil tests will be of considerable help in the better use of fertilizers. Information may be obtained from your district agriculturists or from the provincial soil and feed testing laboratory situated on the university campus in Edmonton.

Crop Succession — Points to be considered in planning a garden include the length of growing season, the space required by mature plants, the location of the perennial vegetable beds, and the possibility of using a succession of crops in any one season. Rhubarb and asparagus may be completely separated from

the main vegetable plot. Short season crops such as radish, lettuce and early cabbage, may be grown quite close to vine crops such as cucumbers and squash. Late cabbage, cauliflower and Swede turnips will require more room. By careful planning a succession of crops such as radish, transplanted head lettuce and winter cabbage may be arranged.

Starting Plants Under Glass — Seeds are sown in plant pots or wooden boxes (flats). The initial seedling growth may take place either in a sunny house window or in a greenhouse or hotbed. If manure is used for making the hotbed, it should be tramped in place at least two weeks before the bed is used. For seed treatment see section on plant diseases.

Transplanting Seedlings — When the young plants are showing their first true leaves, they are ready for transplanting to other containers. For this purpose, boxes of a standard size (about 18 x 12 x 3½ inches) are used. The plants are set 1½ x 1½ inches or 2 x 2 inches apart depending upon the type of plant, and the amount of hotbed space available. Individual containers such as plastic or clay pots may be used. Increasing use of peat pots and bands is also recommended. A mixture of two parts composted soil (garden loam with well-rotted manure) to one part of sand is excellent for growing transplanted plants.

Hardening Off—When frost danger lessens, the young plants are "hardened off" by gradually reducing the moisture, and by increasing direct exposure to both day and night temperatures. When transplanted to the field, place them as deep or a little deeper than they grew in the flats, and firm the soil about the roots.

Field Seeding — Sowing seeds directly in the garden is usual with such vegetables as peas, beans, corn, late lettuce and carrots. Seeds require optimum conditions of temperature and air before they will germinate. Arrange planting time to conform to these conditions.

Cultivation — This is most necessary and begins with thorough soil preparation before the seeds are planted to ensure a uniform consistency of the topsoil. Cultivation after the garden is seeded, especially after rains and artificial watering, will control weeds.

COMMERCIAL HORTICULTURE

Interest in commercial production of horticultural crops is increasing in all parts of Alberta. Fresh market vegetables and processing vegetables are produced for local consumption and for export. Local nurseries supply much of Alberta's nursery stock and are supplying other provinces in Canada. Flower crops grown in greenhouses in "sunny Alberta" are shipped to consumers from Vancouver Island to the Lakehead. Fruit crops are grown to a much lesser extent than vegetables, flowers and nursery stock but the production of small fruits in the province has considerable potential.

To assist commercial growers a number of publications are now available and public meetings and short courses emphasizing commercial production are conducted periodically. A number of growers' organizations, some with national affiliations (e.g. Canadian Horticultural Council, Flowers Canada), have been formed to assist with problems of production, marketing, education and research. For further information on any of these aspects of commercial horticulture see the sources of information.

Sources of Information

1. Local district agriculturist; 2. Alberta Department of Agriculture, Edmonton; 3. Plant Science Department, University of Alberta, Edmonton; 4. Canada Department of Agriculture Research Stations at: Lethbridge, Lacombe, Beaverlodge, Fort Vermilion.

REFERENCE

	Publication No.	Agdex No.
Alberta Department of Agriculture		
Alberta Horticultural Guide	200/01	200/01
Lawn Building and Maintenance	—	273/70
Spring Flowering Bulbs	109	281/20
Forcing of Vegetables	129	250/24
Potatoes in Alberta	137a	161/20
Growing Field Beans in Southern Alberta	148	142/20-1
Pruning Manual for Ornamental Trees, Shrubs	200/24	200/24
Soil Management in Alberta	155	510
Forcing of Vegetatbles	Publication 129	
Potatoes in Alberta	Publication 137a	
Growing Field Beans in Southern Alberta	Publication 148	
Canada Department of Agriculture		
Planning Your Garden	1182	Price $1.00
Descriptive Notes on Herbaceous Perennials for Canadian Gardens	968	282/33
Growing Herbaceous Perennials	970	282/20
Annual Flowers for Canadian Gardens	796	281/20-3
Flowering Bulbs for Canadian Gardens	996	280/20
Living with House Plants (Queen's Printer, Ottawa, for $1.30)		
Transplanting Trees and Shrubs	1168	275/22
Growing Strawberries in Eastern Canada	1171	232/20
Planting and Harvesting	1172	232/20
Diseases	1173	635
Insects	1174	625-2
Vegetable Gardening Practices	1070	250/20-1
Tree Fruits for the Prairies	1222	210
Home Vegetable Growing	Publication 1059	
Vegetable Gardening Practices	Publication 1070	
Handbook for Northern Gardeners	Publication 1081	
University of Alberta		
Small Fruit Growing in Alberta	54	230

OTHER REFERENCES

Planning Your Garden, Queen's Printer, Ottawa, $1., Bulletin 1182

New Design of Small Properties, Bottomley, MacMillan Co., New York.

Planning the Garden, Manual 10, $1, University of California, Davis.

The Art of Home Landscaping, Garrett Eckbo, F. W. Dodge Corporation, New York.

The Ladies Home Journal Book of Landscaping and Outdoor Living, Richard Pratt, M. Evans and Co. Inc., New York.

Farmstead Planning for Greater Production and Better Living, T2, Family Farm Improvement Branch, Saskatchewan Dept. of Agriculture, Regina.

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Sunset Garden Plans, Lane Book Co., Menlo Park, California.

Sunset Landscaping for Western Living, Lane Book Co., Menlo Park, California.

PLANT DISEASES

INTRODUCTION

Disease in plants, as in animals, is an abnormal condition which can be caused by parasitic organisms (infectious) or non-parasitic (non-infectious) factors.

Infectious agents, such as molds, bacteria, viruses, or nematodes, get their nourishment from within the plant. The damage may be obvious and direct, such as the destruction of a part of the plant used for commerce. Other losses, however, are not as obvious, and are more indirect. The plant may be weakened by a root disease or a leaf disease, yet marketable grain may be produced. Such grain may often be of poor quality and frequently there is a lower yield.

Parasitic microorganisms do their damage by interfering with the normal functions of the plant by one or a combination of the following means:

(1) Rob the plant for foods.
(2) Introduce toxins or other harmful substances.
(3) Plug the water and food conducting vessels.

These actions result in visible symptoms like wilts, blights, rots, cankers, stunting, galls or other abnormal growths.

Control can only be effected once the cause of the disease is known. Some symptoms are characteristic of a specific disease, though similar symptoms may be caused by entirely different casual agents.

Growing many individual plants near one another, as in a grain field or orchard, increases the chances for damage due to infections because the disease producing organisms don't have to move very far to infect healthy plants and so cause an epidemic. There is also a greater chance that in such a large population of disease producing agents that a mutation may show up which might be capable of attacking hitherto resistant varieties.

Although many parasitic microorganisms can attack many different kinds of plants, most are limited to a narrow range — sometimes only a few varieties of a given species. Varieties that are badly damaged by the disease are considered susceptible, whereas those that are not are resistant. Various degrees of resistance are known. Plant breeders make use of resistant varieties worth growing.

Non-parasitic diseases generally are due to abnormal environmental factors such as extremes of temperature or an inbalance of soil nutrients. These factors also interfere with the normal development of the plant. Present day cultural practices such as intensive cropping or extending cultivation into virgin land may result in crops showing deficiency diseases. The use of agricultural chemicals such as 2,4-D often causes damage in susceptible crop plants in the vicinity.

Control in these cases is often effected by remedying the cause, once it is known. The following information is intended to acquaint the reader with the symptoms, causes and control measures for the more common diseases of cultivated plants in Alberta.

General Control Measures

The fungi, bacteria and viruses that cause most plant diseases may be carried in or on the surface of the seed or planting stock, in the soil, in diseased tissues or in crop refuse. Weeds and other "wild" plants may also harbour them. Insects may also act as carriers. Control measures are based on these facts. **Specific diseases are covered in table form later in the section.**

RESISTANT VARIETIES

Many plant diseases can now be controlled cheaply and effectively by growing disease resistant varieties. They should be used wherever desirable and adapted ones are available. Stem rust-resistant varieties of wheat and wilt-resistant varieties of flax have, for instance, been widely grown in western Canada to the great advantage of the farmer. It should be recognized though, that

a variety resistant to one disease organism is not necessarily resistant to another and that resistance may not be maintained indefinitely. Hence, it is important to be guided by the latest recommendations of recognized authorities in utilizing this method of disease control.

DISEASE-FREE PLANTING MATERIAL

Since many diseases are carried by seed and other propagating stock, it is good practice to start with reliable planting material. This is especially true for those diseases carried within the seed or planting stock and therefore not controlled by surface chemical treatments. Examples are loose smut of barley and wheat, halo blight of beans, angular leaf spot of cucumber, leaf roll of potatoes, mosaic of raspberries, certain viruses of plum and bacterial ring rot of potatoes. Certified seed or planting stock should be used because of its greater freedom from these plant pathogens.

SEED TREATMENT

Seed treatment not only controls certain seed-borne diseases but it also protects seed from soil-borne microorganisms. Consequently, high-quality seed may benefit from seed treatment, but seed that has been injured will benefit even more. Some seed treatment preparations also contain an insecticide for wireworm control.

Although fungicides are used mainly, disease control may be effected in some instances by heat or simply by soaking the seed in salt water. Different treatments may be needed for different diseases, but some have rather wide application. The organic mercurials are generally recommended for grain. Non-mercurial organic fungicides are used extensively in vegetable seed treatment. Some of them are effective for some grain diseases as well. Choice of products will depend on the seed to be treated, the disease for which protection is desired, preference for a liquid, slurry, or dust form of application, and cost per unit of seed treated.

Choose the fungicide on the basis of effectiveness in disease control and freedom from undesirable qualities. Formaldehyde (formalin) should not be used because it is injurious to seed, even though it is a good fungicide. If an individual is allergic to a certain fungicide, a substitute can usually be found.

Cereals

Cereals are subject to numerous seed-borne diseases. The surface-borne smuts (e.g., bunt of wheat, covered smut, and false loose smut of barley) can be controlled by treating the seed with a fungicide. The true loose smuts of barley and wheat are not controlled by fungicide treatments because the fungi are inside the seed. Proper seed treatment will also protect the seed from other seed-borne and soil-borne microorganism, especially if the seed has been damaged. Threfore, it is generally better to treat than not to treat. Treatments for loose smut and for wireworm control should be employed only when they are known to be present.

Oilseeds

Flax benefits greatly from proper seed treatment, yet much untreated flax is sown. Treated flax is protected from soil-borne microorganisms and for this purpose alone seed treatment is advisable. Seed treatment will also help to control diseases that are seed-borne. Because flax seeds are smaller than those of the cereals, more fungicide per bushel is required to give adequate coverage.

Seed treatment of safflower and sunflower is recommended, but rape and mustard do not generally benefit from it.

Forage Legumes and Grasses

Seeds of forage legumes and grasses are seldom treated. While in special cases seed treatment may be beneficial, no general recommendations for these crops can be made.

Vegetables

Treatment of vegetable seeds, e.g. peas, is recommended for protection from seed rot and damping-off. Potato seed-pieces should be treated to protect them from seed-piece rot. Non-mercurial organic fungicides are generally recommended. For more information check Publication 166 — Seed Treatment For Field Crops. **WARNING — Most seed treatment chemicals are toxic to humans. Follow the directions on the container for dosage rates for the particular crop and read and heed the handling precautions stated on the label.**

CULTURAL PRACTICES

Seeding Precautions

Good growing conditions are very important in preventing damping-off of seedlings. The soil should have sufficient moisture before seeding to carry the plants through this critical stage. Irrigated land should be fall-irrigated to ensure a good moisture supply at planting time. To avoid serious stand reductions by damping-off in crops such as wheat, alfalfa, sugar beets, and peas, they should be planted in cool soil while others such as corn, beans, and cucumbers should be planted after the soil has warmed. Early-sown cereals often escape the most serious effects of rust and yellow dwarf virus.

Cultivation

Leaf diseases and root rots of cereal crops cause significant reductions in yield under certain conditions. The use of trash cover and shallow cultivation practices contribute to the survival and multiplication of disease organisms.

Leaf-inhabiting fungi and bacteria survive on straw and leaf fragments. They pass the winter in a dormant state. In warm, moist weather the fungi produce spores and the bacteria multiply rapidly. Shallow cultivation leaves the plant debris on or near the surface of the ground and, as the seedlings push their way through this straw they become infected by the disease organisms.

These organisms were formerly destroyed to a large extent by burning the straw or ploughing it under. However, because of soil erosion, control of crop diseases must be based on the maintenance of trash cover. In areas where soil drifting is not a major problem, leaf and root diseases may be reduced by an occasional deep ploughing immediately prior to seeding.

Crop Rotation

Crop rotation as a control measure for plant diseases is based on the fact that any particular organism can attack only one or a few kinds of crops. When that crop is unavailable, the organism dies after a certain period of time.

Most organisms that affect leaves are restricted to only one kind of crop. Therefore, replacement of the diseased crop by a different kind of crop is an effective measure for controlling that particular disease. Root-rotting fungi, however, often can attack several kinds of crops. For example, some fungi which cause root rot of wheat also can rot the roots of barley. Therefore, if root rot is a problem, wheat and barley should not follow each other in rotation. Identification of the disease and a knowledge of the kinds of crops which the causal organism can attack is essential for the planning of a proper rotation program.

The use of resistant varieties of summerfallowing has practically the same effect as crop rotation.

Sanitation

Chemical sprays and dusts are useful but are not cure-alls. They should go hand in hand with sound practices designed to eradicate or reduce the sources of infection. Plant debris often harbors disease organisms and allows them to survive adverse conditions. It is, therefore, advisable to remove or burn dead plant material. With virus diseases or with diseases affecting the woody parts of trees, it is good practice to remove and destroy the whole plant or to prune out the affected part. The loss incurred from roguing and pruning will usually be offset by a reduction in the incidence of disease in nearby plants. Weed control is also important as weeds may carry disease organisms that can affect crops.

CHEMICAL CONTROL

Fungicides applied as sprays or dusts are useful in protecting plants from many diseases. Insecticides are used to control insects that transmit certain plant diseases.

Treatments should be made when the air is still. The dust or spray should be forced through the foliage to insure that all parts of the plants are protected.

The first application should be made as soon as symptoms appear or sooner if experience of previous seasons indicates this. Subsequent applications should be made as often as warranted. Moist weather favors the spread of most disease-producers and rain washes off the protective coating of fungicide.

Handle chemicals with caution; follow the manufacturers' directions precisely.

Additional Information

This section provides only general information on the identification and control of the most important diseases occurring in Alberta. Additional information may be obtained through District Agriculturists. The publications at the end of this chapter are also sources of useful information on plant disease problems.

IMPORTANT — In the following tables trade names of products are used as examples only.

DISEASES OF CEREALS AND GRASSES

Disease	Crop	Description	Control
		Kernel and Head Diseases	
Bunt (covered or stinking smut)	Wheat	Balls of black spores in place of kernels. In threshed grain, spores from broken balls blacken brush ends of kernels. Unpleasant odor.	Treat seed with suitable fungicide according to manufacturers' instructions. Use resistant varieties where recommended.
Covered smut	Barley	Kernels become masses of purple-black spores in thin membranes which do not rupture until threshing. Clumps of smut spores are conspicuous in threshed grain.	Treat seed with a suitable fungicide. Because of the hulls on oats and barley some fungicides are not effective, even though suitable for wheat.
False loose smut	Barley	Spikelets replaced by loose, powdery smut masses which are blown away by wind. Smutted heads resemble those caused by true loose smut except that the latter are lighter in color.	Treatment a week or more in advance of seeding is required with some fungicides. Follow directions on the label. Use resistant varieties if recommended for your area.
Covered loose smut	Oats	Dark brown spore masses replace spikelets. May be covered, loose or intermediate type of smut.	
Stalk smut	Rye	Dark spore masses as stripes on stems and leaves as well as in the heads.	Treat seed as for bunt of wheat.
Head smut	Cultivated grasses	Spikelets become powdery masses of black spores. Plants once infected produce smutted heads every year.	Treat seed with non-mercuric fungicide such as Thiram or Captan. Rogue infected plants from seed plots.

PLANT DISEASES

Disease	Crop	Description	Control
Loose smut	Barley	Dusty black spores replace the kernels and are soon blown away by wind, leaving the head bare. Not evident in threshed grain.	Use registered or certified seed and resistant varieties. Treat enough for seed plot as follows: Place two bus. seed in tub or barrel. Add enough one per cent salt water (one pound salt to 10 gals. water) to cover grain. Keep water temperature at 70 - 75° F. for 65 hours. Drain and spread to dry quickly to prevent sprouting. Seed in plot isolated from other barley. Use grain for main planting next year.
Ergot	Grasses, Rye Barley, Wheat	Conspicuous horn-like purple to black fungus bodies in place of seeds; present in threshed grain. Poisonous to man and animals.	Cut all nearby grasses before they head. Clean ergot from seed. If a few ergot bodies remain, sow the seed at least two inches deep. Plow deeply after harvesting an infected crop to bury ergot bodies in the field. Grass hay should be cut before flowering.
Smudge (black point)	Wheat, Barley	Dark brown discoloration, especially prominent on germ end of seed.	Remove lighter seed with fanning mill. Treat seed with a mercurial fungicide.
Blast	Oats	White empty spikelets, usually at the base.	None known.
		FOLIAGE AND STEM DISEASES	
Stem rust	Wheat, Oats Barley, Rye Grasses	Dusty, raised, reddish brown oblong spots on leaves, stems and heads, becoming black as the plants mature.	Use resistant varieties where recommended. Use early varieties or seed early-mature plants which escape rust.
Leaf rust	Wheat, Barley, Rye	Dusty, small round to oval orange spots on leaves and sheaths, becoming black as the plant matures.	As for stem rust.
Scald	Barley, Rye some Grasses	Oval or lens-shaped spots at first grey-green. Later dry to pale or white center surrounded by brown margin.	Include non-susceptible crops in rotation and turn under crop residue where feasible. Treat seed with fungicide.
Spot blotch	Barley Wheat, Rye	Dark brown oblong to round spots that may fuse to form blotches.	As for scald.
Net blotch	Barley	Brown elongate areas with a network of darker brown lines.	As for scald.
Septoria leaf and glume blotch	Wheat, Barley	Light brown blotches on leaves and glumes that become speckled with black dots. Mature straw is dirty grey.	As for scald.

Disease	Crop	Description	Control
Bacterial blight	Barley	Narrow, glossy-surfaced stripes on leaves, at first water soaked, changing to dark brown and finally translucent. Affected areas produce droplets of sticky ooze.	As for scald.
Halo blight	Oats	Pale yellowish-green oval spots with small, dead, sunken centers.	Seed treatment, sanitation and rotation reduce the severity of the disease.
Wheat streak mosaic	Winter and spring Wheat, Barley	Light green to yellow streaks on leaves. Plants may be severely stunted.	Avoid fall-infection of winter wheat by destroying volunteer growth in the same or adjacent fields at least a week before seeding. Seed September 1 - 15 in south Alberta. Do not plant spring wheat adjacent to diseased winter wheat.
False stripe	Barley	Leaves have yellow stripes that turn to dark brown, and usually terminate in a V-shape.	Avoid seed from infected crop.
Leaf banding	Cereal seedlings	One or more narrow white bands on seedling leaves or sheaths. Often causing break-over at these points. Caused by either high or low (freezing) surface soil temperatures.	Trash cover gives some protection. Seedlings normally recover.
Yellow dwarf Grey speck	Barley, Wheat Oats	Leaves of barley and wheat turn golden yellow from tips downward, principally along margins. Oats similarly affected but turn various shades of red. Severe stunting results from seedling infection.	Severe damage by this aphid-carried virus is best avoided by early seeding.
Grey Speck	Oats, Barley, Wheat,	Numerous white-brown dead areas cause otherwise green leaves to break-over. Most commonly found in oats growing on peaty soils of foothill region, deficient in manganese. Non-infectious disease.	Avoid highly susceptible oat varieties, Eagle, Garry, and Rodney. Use more tolerant varieties. Glen, Abegweit, and Larain. Wheat and barley are more tolerant than most oat varieties.
Powdery mildew	Cereals, Grasses	White powdery growth on surface of leaves. May turn brown and speckled with minute black dots.	Seldom serious except occasionally on irrigated land. Valuable seed plots may be dusted with sulphur.
Cold and winter injury	Grasses	Plants dead in spring, usually in patches. Crown and roots decayed.	Use hardy varieties. Avoid late fall cutting, over-grazing, and burning.

ROOT DISEASES

Disease	Crop	Description	Control
Common root rot	Wheat, Oats, Barley, Rye, Grasses	Plants stunted and generally lacking in vigor. Brown discoloration of stem bases, roots, crown, and lower leaf sheath. Increases in severity after successive susceptible crops.	Rotate cereals with legumes, or rape. A two-year period without susceptible crops will reduce level of infection. Oats are least susceptible of cereals. Where possible plow to bury contaminated surface soil and trash, preferably just before seeding. Treat seed with mercury fungicides.
Seedling blight	Cereals	Seed rotting and death of seedlings before or shortly after they emerge cause thin stands.	Treat seed with a recommended fungicide.
Take-all root rot	Wheat, Barley, Grasses	Occurs in scattered plants or patches in black and dark brown soil zones. Plants stunted and bleached. White heads with shrunken kernels. Roots shiny black and brittle. Plants easily pulled.	After breaking sod use rotation wheat, oats, wheat, fallow, followed by long term rotation. Destroy grasses in fallow. Maintain soil fertility. Take-all may become troublesome if wheat follows wheat.
Browning root rot	Wheat, Oats, Barley, Millet, Grasses	Brown spots in crop show in June. Lower leaves extensively browned and dead. Seedlings are stunted, maturity delayed and yields lowered. Most common in wheat on fallow.	Use phosphate fertilizers for crop on fallow. Maintain soil fertility. Sow in a firm seed bed. Work in combine stubble.

DISEASES OF OILSEED CROPS AND SUGAR BEETS

Crop	Disease	Description	Control
Flax	Browning (Stem Break)	Most conspicuous after flowering as brownish blotches on stems, leaves, and seed capsules. Some plants break over just above soil surface.	Avoid sowing flax after flax and leaving stubble exposed near new flax. Use clean seed. Treat seed.
Flax	Rust	Small reddish powdery pustules mainly on leaves in mid-summer and smooth black blotches chiefly on stems later in season.	Follow above measures and use a rust-immune variety if one suited to your district is available.
Flax	Seed Rot and Seedling Blight	Poor emergence due to seed decay in the soil. Some seedlings wilt and die.	Treat seed. A shallow, firm seed bed results in less damage.
Flax	Pasmo	Symptoms similar to those of browning. Develops later in season, and plants do not break over.	As for browning or stem break.

Crop	Disease	Description	Control
Flax	Wilt	Plants may wilt wholly or partially at any stage. Tips of plants bend downwards.	Most newer varieties are wilt-resistant and should be grown. Seed early. Rotate crops.
Flax	Yellows	Leaves yellowish, bunched at top, and flowers greenish and deformed. Seed capsules fail to develop.	Eradicate weeds near flax fields to reduce spread by insect carrier (small leafhopper).
Flax	Heat Canker	Plants girdled at ground line. Often fall over.	Early and heavy seeding.
Mustard Rape	White Rust	Small, raised white areas on stems and leaves. Infected flower parts are enlarged and distorted.	Use clean seed. Rotate crops.
Mustard Rape	Downy Mildew	Yellow lesions with downy mold on the leaves. Large, brown irregular-shaped growths in place of some normal seed pods.	Same as above. Often both diseases occur as a complex.
Mustard Rape, Sugar Beets	Seedling Blight	Seedlings wilt and die.	A shallow, firm seed bed results in less damage.
Rape, Sunflower	Wilt and Basal Rot	Leaves wilt, decay, and base of stem rots. Hard, black fungus bodies may occur in or on diseased tissues. Heads and seeds may be affected occasionally.	Rotate with cereal and grass crops. Use clean seed. Control weeds as many harbor causal fungus.
Safflower	Rust	Red rust appears in small tufts on leaves and stems. Infection often girdles seedlings at ground level causing them to wilt and break-off.	Rotate crops. Avoid seeding safflower adjacent to infected safflower stubble. Treat seed.
DISEASES OF FORAGE LEGUMES			
Safflower	Leaf Spot	Irregular, brown spots on lower leaves and when severe on outer flower parts.	Rotate crops and treat seed.
	Root Rot	Plants wilt and die.	Use a resistant variety. Rotate crops and treat seed.
Sugar Beets	Black Root	Brown and black discoloration of stem and roots of seedling.	Maintain soil fertility, rotate crops, and treat seed.
	Leaf Spot	Leaves have light brown spots with poorly defined margins. Speckling may occur within the spots.	Rotate crops and treat seed.
	Root Nematode	Unthrifty plants in patches.	Rotate to grow beets not oftener than every four years.

Crop	Disease	Description	Control
Sunflower	Rust	Rust-colored spots appear on leaves and sometimes on stems and lower surface of the head. As plant matures spots on stems turn black.	Rotate crops.
Sunflower	Downy Mildew	Yellow areas with downy mold on leaves. Severe stunting of plants and seeds are empty.	Rotate to grow sunflowers not oftener than every three or four years.
Sunflower	Leaf Mottle	Tissues between veins of affected leaves become pale green, then yellow and finally die and turn brown.	Rotate crops.
Sunflower	Wilt	Covered under Rape above.	
Alfalfa	Crown Bud Rot	Decay of crown buds during growing season. The disease is favored by conditions that promote rapid growth.	Avoid late cutting and excessive grazing. Use wide crop rotation.
Alfalfa	Winter Crown Rot	Patches of plants are killed in early spring. Fungus can sometimes be seen covering plants after snow has melted.	Plant winter hardy varieties and avoid late cutting and grazing of alfalfa land.
Alfalfa	Winter Injury	Dead plants occur singly or in patches especially under ice or in gateways under excessive trampling. Plant crowns and upper portions of roots are shredded.	Plant winter hardy varieties. Avoid excessive grazing.
Alfalfa	Bacterial Wilt	Plants are reduced in vigor, are stunted, and may have tiny yellowish leaves. Heavily diseased plants have brown ring in interior of root.	Plant resistant variety of alfalfa sufficiently winter hardy for area. Recommended varieties are listed in forage crop section.
Alfalfa	Black Stem	Black or dark brown areas on leaves, stems, and seed pods. Heavily infected plants may drop their leaves and seed pods.	Early spring burning of stubble and crop debris before new growth begins. Make first cutting of hay as early as possible.
Alfalfa	Common Leaf Spot	Small circular brown spots on leaves. These spots later develop raised centers. Heavily infected leaves may drop off.	Cut hay crop early enough to catch leaves before they fall.
Alfalfa	Seedling Blight	Rotting of seed, death of seedlings before or shortly after they emerge, resulting in thin stands.	Treat clean seed with non-mercurial fungicides such as Thiram or Captan. If treated seed is to be inoculated, do it just before seeding to avoid damage to nodule-forming bacteria.

Crop	Disease	Description	Control
Alfalfa	Witches' Broom	Small, yellowish leaves with dried edges borne on unusually large numbers of fine stems giving a "broom-like" appearance to plant.	Maintain healthy thick stand. The disease is spread by an insect that does not like shady moist conditions.
Red Clover	Northern Anthracnose	Brown, sunken areas on stems, cracking of stems, girdling of petioles and wilting of above parts, resulting in a reduced yield.	Crop rotation.
Red Clover	Powdery Mildew	Light grey, powdery growth on upper surface of leaves. Leaves turn yellow and eventually brown where infection is sufficiently severe.	No economical control measures are available.
Alsike Clover Beans	Sooty Blotch	Prevalent in low, wet areas. Dark brown or black blotches on lower surface of leaves. Later in season, infected leaves wither when blotches are numerous.	Treat seed with Captan or Thiram.
DISEASES OF VEGETABLES			
Beans	Halo Blight	Small water-soaked spots on leaves develop into brown, dead areas of varying size and shape, often bounded by a yellow margin or halo. Brownish-red, dry, sunken lesions appear on pods.	Do not sow discolored seeds or those from spotted pods. Use guaranteed "blight-free" seed. Do not work around plants when foliage is wet. Burn diseased crop refuse. Rotate crops.
Beans	Anthracnose	Dark brown lesions on all above-ground parts. Most striking symptom is formation of large, deep, dark-colored cankers on immature pods.	As for halo blight.
Beans	Mosaic	Mottling (light and dark green) and puckering of leaves, stunted plants; blossoms tend to drop and pods are shorter than normal.	Grow mosaic-resistant varieties such as Contender, Tender-long No. 15 Top-crop, Puregold Wax, Kentucky Wonder, and Blue Lake.
Beets	Seed Rot and Damping - off	Poor seedling stand. Seedlings collapse and die.	Treat seed with Captan or Thiram. Avoid excessive moisture.
Beets	Leaf Spot	Numerous small spots with light tan or grey centers and dark brown borders.	Treat seed with a fungicide. Spray or dust plants with a copper fungicide only if the disease is severe. Rotate crops. Clean up and burn refuse.

PLANT DISEASES

Crop	Disease	Description	Control
Cabbage and related plants	Damping-off	Poor stand, seedlings collapse and die.	Treat seed with a fungicide. Maintain even moisture supply.
Cabbage and related plants	Black Rot	Leaves turn yellow, then black in V-shaped areas from margins inward. Blackened veins.	Use disease-free seed or soak seed in water maintained at 122° F. for 30 minutes, dip in cold water, dry thoroughly. Crop rotation in field and seedbed.
Carrots	Yellows	Yellowing of young leaves, reddening and twisting of older leaves. Small, hairy and poor quality roots.	Damage reduced by controlling weeds and leafhoppers that are carriers of disease virus. (See insect section.)
Celery	Late Blight	Small, yellow spots on older leaves and stalks turn dark grey-brown and become covered with tiny black specks.	Spray with 8-8-100 Bordeaux mixture or use a copper-lime dust at weekly intervals. Remove and destroy plant debris in fall.
Corn	Seed Rot Smut	Poor stands. Large, whitish, gall-like growths on stalks, ears, or tassels that burst and release a black, powdery mass of spores.	Treat seed. Do not sow in cool soil. Remove and destroy affected plants.
Cucumber	Angular Leaf Spot	Small, water-soaked spots on leaves, stems, and fruits. On leaves these spots develop into tan, angular spots that are gummy or shiny on the under-surface. Spots on stems and fruits covered with a white exudate. Fruits may rot.	Destroy plant debris. Plant disease-free seed. Rotate crops. Do not harvest when plants are wet.
Cucumber	Bacterial Wilt	Leaves and vines wilt and die. A sticky ooze is found when wilted stems are cut.	Remove and destroy wilted plants as soon as found.
Lettuce	Sclerotinia (drop)	Progressive wilting and rotting beginning with outer leaves. Whole plant collapses and rots.	Remove and burn plants as soon as symptoms appear. Rotate with non-susceptible crops such as corn or potatoes.
Onion	Neck Rot	Rotting of stored bulbs, usually at the neck. Grey fungus growth often containing small, black bodies.	Cure thoroughly and store at slightly above 32° F. with good ventilation. Colored varieties are more resistant than white ones.
Peas	Seed Rot	Poor seedling stand.	Treat seed with Captan or Thiram. Plant in cool soil.

Crop	Disease	Description	Control
Peas	Leaf and Pod Spot	Circular or irregular tan or purplish-brown spots with darker margins on leaves, pods, and base of stem. Spots on pods are sunken.	Burn diseased vines after harvest. Use disease-free seed.
Peas	Mildew	White, fluffy, or powdery growth on leaves, stems, and pods, later dotted with dark specks.	Dust or spray plants with sulphur.
Peas	Root Rots and Wilt	Base of stem rotted, plants yellowish, wilted or both.	Follow a four-year rotation. Avoid excess moisture. Sow wilt-resistant varieties.
Peas	Bacterial Blight	Small, glistening, brown spots on leaves. Larger water-soaked spots on pods and stems.	Rotate with other crops. Use disease-free seed.
Peas	Leaf Blotch	Indefinite areas turn pale or yellow and spread to cover the whole leaf. Numerous pin-point, black bodies appear on lower leaves and stem.	Rotation is the main control measure.
Potato	Early Blight	Small, irregularly-shaped, dark brown spots on leaves with target-like markings.	Plant certified seed. Spray with Maneb, Zineb or Bordeaux Mixture 10-10-100. Repeat as necessary.
Potato	Late Blight	Irregular-shaped, rapidly enlarging, dark-brown areas on leaves surrounded by a water-soaked border. Infected tubers first show a purple discoloration of skin that later develops into a brownish dry rot in the hill or during storage.	As for early blight. Do not store diseased tubers.
Potato	Bacterial Ring Rot	Yellowing, rolling, and death of leaves. Plant wilts. When cut open, tubers and stems show an internal brown ring. Tubers rot in hill or during storage.	Plant certified seed. If cutting seed tubers disinfect knife after each cut. Disinfect all machinery and storages. notify your District Agriculturist.
Potato	Leaf Roll	Rolling and yellowing of leaves. Stunted plants. Small tubers.	Plant certified seed. Dig and destroy diseased plants. Control insect carriers (aphids and leafhoppers).
Potato	Common Scab	Rough, corky brown scabs on tubers.	Rotate with legumes or grains. Use resistant varieties as Netted Gem.

Crop	Disease	Description	Control
Potato	Rhizoctonia	Brown cankerous areas at base of stems. Tops may show rolling and reddening of upper leaves. Aerial tubers may form in leaf crotches. Tubers often have specks of black "dirt" that is not easily washed off.	Plant certified seed. Rotate with grains.
Potato	Black Leg	Base of stem soft black and shrivelled. Branches rigid and upright and leaves pale. Tubers rot starting at stem end. Vile odor to rot.	Plant certified seed. Seed pieces should be planted as soon as cut or kept in cool, well-ventilated storage. Destroy potato refuse after harvest. Rotate crops.
Tomato	Early and Late Blight	Leaf symptoms are the same as for potato. Fruit has dark, leathery decayed spots.	Spray early with Maneb or Zineb and repeat at 10-day intervals.
Tomato	Leaf Spot	Small spots on leaves with grey brown centers and dark margins. Dark specks in centers of spot.	Destroy vines in fall. Rotate crops.
Tomato	Blossom-end Rot	Large sunken leathery rot occurring only at blossom end of fruit. Condition is usually caused by soil drying quickly when plants are growing vigorously.	Maintain an even moisture supply.
Tomato	Wilt	Leaves dull green, plants stunted. Inner tissue of stem has brownish discoloration.	Rotate with cereals. Do not plant tomatoes on infested land.

DISEASES OF SMALL FRUITS

Plant	Disease	Description	Control
Strawberry	Leaf Spot	Reddish-purple spots on leaves later turn grey with a purple border.	Spray with Captan in the middle of May and again in early June.
Strawberry	Powdery Mildew	Leaves curl upwards, white powdery growth occurs on under-surface.	Dust leaves with sulphur when buds are unfolding and at 12-day intervals for next five weeks.
Strawberry	Yellow-edge	Central leaves dwarfed and "cupped" with yellow edges. Outer leaves more or less normal. Fruit is small.	Remove and burn all infected plants and their runners as soon as symptoms appear. Obtain virus-free stock.
Strawberry	Red Stele	Leaves small, bluish with short stems. Little or no fruit produced. Roots long stringy, have a characteristic dark red core.	Destroy diseased plants and runners. Plant disease-free stock in new location.

Plant	Disease	Description	Control
Raspberry	Mosaic	Leaves on new canes and/or on laterals of fruiting canes are at first light green, then become mottled with yellow and tend to pucker.	Rogue out and burn diseased and adjacent plants. If extensive, destroy entire plantation. Replant more than 100 yards away. Use certified virus-free stocks.
Raspberry	Leaf Curl	Leaves wrinkled, curled, and darker green than normal.	As for mosaic.
Raspberry	Crown Gall	Plant stunted. Knobby swelling on roots.	Destroy infected plants. Plant disease-free stock in new location.
Raspberry	Spur Blight	Dark red or chocolate-brown spots on leaf stalks and young bark. Fruit spurs weak, chlorotic and seldom bloom.	In fall, prune out and burn all old canes and any diseased young canes. Spray with Bordeaux 3-6-40 when young canes are 8 - 10 inches high.
Currants, Gooseberry	Powdery Mildew	White, flour-like coating on young leaves and fruit, becoming light-brown and felt-like.	Spray when leaves begin to emerge and twice more at 12-day intervals with Captan or wettable sulphur. Grow recommended resistant varieties.

DISEASES OF FRUIT AND SHADE TREES

Tree	Disease	Description	Control
Apple Crabapple Pear Mountain Ash	Fireblight	Blossoms and leafy shoots suddenly wilt, turn brownish-black, shrivel and die as if scorched by fire, but remain on tree. Later cankerous areas of shrunken and discolored bark may appear on branches at base of affected shoots.	Use resistant varieties. Diseased wood should be removed as soon as it appears, cutting about six inches below discolored area. Wash pruning knife and cut surfaces with a solution of one part mercuric chloride to 500 parts water or household bleach full-strength, after each cut. Burn the diseased wood.
Apple	Apple Scab	Dark, green, velvety spots on leaves and fruits. On fruit these develop into dark brown scabs.	Spray with lime-sulphur, Bordeaux mixture, or Ferbam in spring and early summer. Burn leaves in fall.
Plum, Cherry	Brown Rot	Blossoms turn brown prematurely. Watery, brown spots enlarge and rapidly envelop fruits and later become covered with greyish powder. Fruit dies and shrivels.	Lime sulphur, wettable sulphur, Phygon, Captan, or Ferbam sprays at blossom and early fruit stage will check spread of rot. Cut out and burn diseased twigs. Burn all rotten or mummified fruits.

Tree	Disease	Description	Control
Cherry, Plum	Black Knot	Velvety, olive-green thickenings appear along the twigs in spring and by fall develop into conspicuous black, hard, and rough-textured knots.	Cut out and burn infected wood 3 - 4 inches below knot. Spray with lime-sulphur or other fungicide when leaf buds start to open.
Plum, Cherry	Shot Hole (leaf spot)	Small red or brown spots on leaves. The centers of these spots drop out giving a "shot hole" effect.	Spray trees with lime-sulphur (1) in late April, (2) immediately after petals fall, and (3) 10 - 14 days later. Burn fallen leaves.
Plum, Cherry	Powdery Mildew	White, fluffy, or powdery growth on leaves.	Spray with lime-sulphur, wettable sulphur or Bordeaux mixture.
Plum	Plum Pocket	Small, whitish spots on fruits a week or two after blossoms drop. Affected fruit becomes puffy and enlarged into bladder-like structures with a grey powdery covering.	Prune branches severely and spray with lime-sulphur just before the buds open.
Plum	Silver Leaf	Branches bear leaves having a dull leaden or metallic lustre and may die the first season that silvering appears.	Remove and burn branches at first sign of silvering. Heavily diseased trees should be dug out and burned. Paint or shellac pruned surfaces.
Poplar, Willow	Cytospora Canker	Brown, sunken cankers on stems and large branches covered with numerous reddish or reddish-brown coiled masses of spores in spring; later small black pimple-like fruiting bodies develop. Parts above cankers die.	Primarily a disease of weak trees. Most effective prevention is maintenance of high tree vigor by eliminating competition, fertilizing and watering. Prune to ground level if necessary. Sprouts from roots will replace infected tree. Prunings should be burned.
Aspen	Hypoxylon Canker	First symptom is small yellow to reddish-brown slightly sunken area on stem. As canker enlarges infected bark becomes mottled grey and black. Canker grows each year and may reach three or more feet in length. Welts of black fungus tissue are visible beneath peeled bark.	The disease is highly infectious and destructive. Infected trees should be cut down and burned.
Poplar	Septoria Canker	Causes leaf spotting of all poplars and stem canker of hybrid poplars.	Most effective control is propagation of naturally resistant hybrids. Burn fallen leaves in fall — major source of infection.

Tree	Disease	Description	Control
Poplar, Willow	Leaf Rusts	Yellowish-orange pustules on lower leaf surfaces.	Rarely cause enough damage to necessitate special control measures.
Lodgepole Pine, Spruce	Needle Rusts	Several species of rust fungi occur on conifer needles. White pustules appear on the needles which turn yellow and drop prematurely.	Spraying or dusting of the trees with sulphur early in the season will provide control.
Scotch Pine, Lodgepole Pine, Spruce	Needle Cast	The needles turn yellow and later bear black oval or elongated irregularly shaped pustules.	Rarely causes sufficient damage to large trees to warrant control. On small trees and nursery stock apply Bordeaux Mixture (4-4-50) or other copper spray when needles are half grown and again about two weeks later. Casein soap should be added as a spreading agent.

DISEASES OF TURFGRASS

Plant	Disease	Description	Control
Turfgrass	Snow Mold	Circular to irregular shaped areas are damaged or killed. Early in spring white-mold growth is often seen in affected areas.	Fall application of equal parts of calomel and corrosive sublimate at the rate of four ounces per 1,000 sq. ft. Apply mixture with enough dry sand to assure even distribution.
Turfgrass	Fairy Ring	Circles of greener grass give first indication. Under moist conditions the causal fungus produces brown mushrooms. In advanced stages grass often killed leaving a ring of bare ground.	Complete soaking of infected area is an essential factor for control. Best done by a hydrogun on a garden hose with water injected into affected area. Fertilizer use will assist recovery.
Turfgrass	Melting (Fading-out)	Symptoms often appear during warm part of growing season. Large and small brown patches occur in grass and sometimes destroy entire lawn.	Apply Captan 50 per cent W.P. at 2 lbs. in 10 gals. water per 1,000 sq. ft., or Dyrene at 4 ozs. in 10 gals. water per 1,000 sq. ft.
Turfgrass	Rust	Stem rust, particularly on Merion bluegrass, is quite common. Small reddish pustules form on leaves and stems.	Rust pustules require about nine days to develop from time of infection. Frequent clipping prevents disease from appearing on upper leaves. Liberal applications of nitrogen fertilizer and water help prevent disease.

Plant	Disease	Description	Control
Turfgrass	Powdery Mildew	Greyish-white cobwebby growth on upper surface of leaves. Leaves become pale yellow.	Reduce shading and improve air drainage. Apply Cyclohexamide at two gals. of 60 p.p.m. per 1,000 sq. ft.
Turfgrass	Brown Patch	Irregular brown patches, a few inches to several feet in diameter. Often first symptoms are purple rings on turf. Diagnosis can be confirmed by a qualified plant pathologist.	Inorganic mercurial fungicides such as Caloclor or Merfusan mixed with dry sand and applied at rate of three ozs. mercury per 1,000 sq. ft.

General recommendations to follow for prevention of turf diseases :

(1) Select species of grass that are less susceptible to most diseases, e.g. common Kentucky bluegrass for lawns and fairways and Northland creeping bentgrass for golf and bowling greens. Red Top or Colonial bentgrass should never be used alone or in turf mixtures because they are susceptible to most diseases and tend to choke out more desirable species during the establishment of the sward.

(2) Fertilizer at the rate of one pound of nitrogen per 1,000 square feet per month and water heavily at regular intervals rather than daily light sprinklings.

(3) Avoid buildup of thatch by removing clippings and periodically use a vertical-cut lawn mower (Reno-thin).

DISEASES OF ORNAMENTALS

Plant	Disease	Description	Control
China Aster	Wilt	Plants stunted often showing one-sided development, yellowing, wilting, blackening and rotting at base.	Grow wilt-resistant varieties. Start seedlings from treated seed (soak ½ hour in 1 : 1,000 mercuric chloride) in sterilized soil or purchase healthy seedlings. Practise rotation.
China Aster	Yellows	Plants first turn yellow along veins, become pale, stunted, branch abnormally, fail to form flowers or produce greenish distorted ones. Effect often one-sided. Wilting does not occur.	Destroy diseased plants. Destroy weeds in vicinity. Spray with DDT to control leaf-hoppers which spread the virus.
Begonia	Powdery Mildew	White powdery coating forms on surface of leaves.	Spray with wettable sulphur or Karathane.
Begonia	Bacterial Leaf Spot	Small circular blister-like spots develop first on leaves, enlarging and joining later. Affected leaves may fall early. Stem may soften and plant collapse.	Avoid crowding and high humidity. Spray Bordeaux mixture. Destroy badly diseased plants.

Plant	Disease	Description	Control
Carnation	Rust	Pustules of reddish-brown spots burst through the surface of leaves and stems. Plants may be somewhat stunted and deformed.	Keep foliage dry. Be sure cuttings are free from rust. If necessary spray weekly with a fungicide such as Captan or Zineb.
Carnation	Fusarium Wilt	Wilting and withering of shoots, often one-sided. Brown streaking of stems and yellowing of both leaves and stems may occur.	Propagate from healthy cuttings. Plant in uncontaminated or sterilized soil.
Chrysanthemum	Verticillium Wilt	Yellowing and browning of leaves from base upwards—stunting and failure to form flowers may result.	Use healthy cuttings, sterilize soil and benches in greenhouse or practise rotation in field. Grow resistant varieties.
Chrysanthemum	Powdery Mildew	Leaves partly or completely covered with white powdery coating. Sometimes stunted and deformed.	Keep foliage as dry as possible. Spray plants with wettable sulphur or Karathane.
Delphinium	Powdery Mildew	Surface of leaves more or less covered with powdery growth speckled with tiny black bodies late in summer. Deformity and stunting. Dying of leaves from base upwards.	Dust with sulphur or spray with wettable sulphur or Karathane. Destroy all fallen leaves and other plant residues in fall. Avoid crowding of plants.
Delphinium	Black Leaf Spot	Irregular shining black spots on leaves and sometimes on buds and stems.	Remove and destroy affected leaves. Spray with Bordeaux mixture.
Gladiolus	Scab	Small reddish-brown spots form, especially on lower leaves. In severe cases may rot at neck resulting in breaking over of plant. Corms develop circular lesions up to ¼" wide which darken to brown or almost black, are sunken and have raised margins.	Dust stored corms with insecticide, e.g. Dieldrin plus a fungicide, e.g. Panoram D-31.
Gladiolus	Fusarium Dry Rot	Mainly a corm rot, but also affects foliage, flowers, and roots. Corms develop brownish-black dry rot with sunken and wrinkled concentric rings. Leaves turn yellow-brown and die. Sections of roots turn brown.	Discard diseased corms. Soak corms 20 - 30 min. in Captan suspension (12 ounces 50 per cent Captan W.P. in five gal. water). Rotate crops.
Hollyhock	Rust	Small brown spots about pin-head size develop mostly on undersides of leaves but also on other green parts.	Cut back to base in fall and destroy all residues that may harbour fungus. Remove any new leaves showing rust. Spray with wettable sulphur or Zineb.

Plant	Disease	Description	Control
Lily	Botrytis Blight	Reddish-brown oval to circular spots on leaves turning grey with age. Affected leaves may die. Similar spots may occur on stems, buds and flowers.	Destroy tops of plants in fall. Avoid crowding. Spray with Bordeaux mixture or dust with copper-lime.
Pansy	Powdery Mildew	Surface of leaves covered with white powdery fungal growth.	Dust foliage with fine sulphur or spray with wettable sulphur or Karathane.
Peony	Botrytis Blight	Brown lesions on stems, buds and leaves. Rotting of crowns and roots may occur. Shoots may rot at ground line, wilt and fall over.	Thoroughly clean-up all plant remains in fall, cutting off old stalks just below soil surface. Soak soil around emerging shoots and spray plants with Bordeaux mixture.
Rose	Black Spot	Black circular leaf spots usually with fringed margins. In later stages yellowing and shedding of affected leaves often occurs.	Destroy old leaves in fall and cut back diseased canes severely. Dust or spray growing plants with fungicide, e.g. sulphur-copper dust or Captan or Zineb.
Snapdragon	Rust	Reddish-brown pustules form on leaves, stems and pods. If severe, leaves and even entire plants killed.	Grow rust-resistant varieties. Use rust-free seedlings or cuttings. Spray at two week intervals with Zineb.
Snapdragon	Sclerotinia Stem Rot and Wilt	Lesions at first water-soaked later a greyish to brownish color on stems near base. Fluffy white growth with black irregular hard bodies (up to 1/4 inch) may form on lesions. Separate branches or whole plant may wilt and die. Many other plants may be attacked.	Avoid introduction of casual fungus. Grow own seedlings in sterilized soil or purchase reliable ones. Sterilize soil by steaming (one hr. at 131° F.) Long rotations, prolonged flooding or soil fungicides, e.g. Vapam or Terraclor will reduce damage.
Tulip	Fire	Leaves, flowers, stems, develop light grey areas with brown borders. Stems may rot off. Diseased parts overgrown with grey mold with tiny black bodies, especially on basal lesions.	Plant disease-free bulbs in soil that has not grown tulips for three years or longer. Destroy diseased plants. Spray plants with a fungicide, e.g. Captan, Zineb or Ferbam.
Sweet Pea	Fusarium Root Rot	Wilting and collapse of plant. Brown lesions on stem and main root, especially near soil surface.	Practise rotation or grow plants in sterilized soil. Treat seed with a protective fungicide, e.g. Captan.
Caragana	Septoria Leaf Spot	Brown spots on leaves with tiny dark specks on the under surfaces. Premature defoliation.	Destroy fallen leaves in fall or early spring. Spray with Bordeaux mixture every two weeks.

Plant	Disease	Description	Control
Cotoneaster	Fireblight	See under Apple.	See under Apple.
Elder	Crown Rot	Bases of stems, crown and root rot. Leaves and stems wilt and die.	Destroy diseased plants. Plant healthy bushes in new locations.
Honeysuckle	Powdery Mildew	See under Begonia.	See under Begonia.
Lilac	Phytophthora Blight	Tips of suckers blight and turn dark brown. Leaves on older branches develop brown blotches.	Prune suckers and any diseased parts. Provide good air circulation around bushes. Spray foliage with Bordeaux mixture.
Lilac	Bacterial Blight	Similar to Phytophthora Blight, but lesions darker.	As for Phytophthora Blight.
Mountain Ash	Fireblight	See under Apple.	See under Apple.
Mountain Ash	Cytospora Canker (Dieback)	See under Poplar and Willow.	Prune affected branches well below cankered areas. Keep trees vigorous by watering and fertilizing.
Mayday Tree	Black Knot	See under Cherry.	See under Cherry.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Varieties of Grain for Alberta	91	110/32
Alberta Horticultural Guide		200/01
Seed Treatment for Field Crops		632-4
Bacterial Ring Rot of Potatoes in Alberta	178	635-3
Canada Department of Agriculture		
Diseases of Field Crops in the Prairie Provinces	1008	

CROP INSECTS

Cultural practices are effective and practical for preventing damage by some insects. Before applying insecticides, find out if the insects can be culturally controlled. If not, recommended chemical measures should be used if expected damage will justify their cost.

Efficient chemical control depends on knowledge of habits of pest insects, early identification of insect damage, and proper timing and application of insecticides.

WARNING — Many insecticides should not be applied to forage or pasture intended for milk cows or for animals going to slaughter in the current year. Some chemicals remain as residues on the foliage. When eaten, these insecticides concentrate in butterfat and in the body fat of the animal. The health of the animal may not be affected, but the meat or milk can be a hazard to the health of consumers. The producer should realize that he has a responsibility in this matter. Contaminated food products are liable to confiscation at the expense of the producer.

INSECTICIDE FORMULATIONS

Insecticides are sold as prepared mixtures or formulations and not in the pure form. Formulations are designed for specific purposes, ease of handling, and for reduction of hazards to man, animals and plants.

Emulsifiable concentrates — These are insecticides dissolved in a solvent or oil with an emulsifying agent. They form emulsions when added to water. They do not readily separate out and can be sprayed with low-pressure equipment.

Oil solutions — These are insecticides dissolved in solvent mixed with oil. These are not to be applied to plants, but are used on livestock and as space sprays.

Soluble powders — These are insecticides on dry powder. They dissolve in water and can be used in low-pressure equipment.

Wettable powders — These are fine dust particles impregnated with insecticide. A wetting agent is added to permit the particles to be suspended in water. They require constant agitation and can be used only with piston or diaphragm pumps. This is because they cause severe wear in gear-type or impellor pumps. Wettable powders should be sprayed at high pressures as they clog low pressure nozzles.

Dusts — Dust fine particles of insecticide mixed with an inert carrier such as talc. Dusts will not mix with water but must be applied with a dust applicator.

Granular formulations — These are formulations ready to use. The insecticide is impregnated on granules of vermiculite or other carrier. These are applied with fertilizer applicator or special applicator, mainly for soil insects.

How to Calculate Amount Required

Control recommendations are usually given as the weight of actual insecticide per acre. If this information is not given on the label, it is necessary to convert the recommendation to equivalent amounts of formulation.

The labels of emulsifiable concentrates usually specify the weight of insecticide in pounds per gallon. The labels of some only specify the percentage concentration; thus a 50 per cent solution would contain five pounds of insecticide per 10 pounds of solution.

(For easy conversion see following table.)

See Control of Field Crop Insects, Alberta Department of Agriculture, Publication 632, for recommended insecticides. This publication is issued yearly. Obtain your copy from your District Agriculturist or Extension Service, Alberta Department of Agriculture, Edmonton.

Rates are frequently given in ounces per 40 gallons of water. To mix smaller quantities of spray, use the following table:

Recommended rate per 40 gals. water	Amount of Emulsifiable Concentrate for same strength in following quantities water		
	25 gals.	5 gals.	1 gal.
2 fl. oz.	7½ tsp.	1½ tsp.	⅓ tsp.
3 fl. oz.	4 tbsp.	2¼ tsp.	½ tsp.
5 fl. oz.	3 fl. oz.	3¾ tsp.	¾ tsp.
7 fl. oz.	4 fl. oz.	5¼ tsp.	1 tsp.

Recommended rate per 40 gals. water	Amount of wettable or soluble powder for same strength in following quantities water		
	25 gals.	5 gals.	1 gal.
2 oz.	4 tbsp.	2½ tsp.	½ tsp.
3 oz.	5½ tbsp.	3⅓ tsp.	⅔ tsp.
5 oz.	3⅓ oz.	5½ tsp.	1 tsp.
7 oz.	4½ oz.	8 tsp.	1½ tsp.

Table to convert recommended rates of actual insecticide to amounts of formulation required.

Commercial formulation	Concentration of insecticide in formulation	AMOUNT OF FORMULATION To give 1 oz. of insecticide	To give 1 lb. of insecticide
Dusts and granules	1%	6¼ lb.	100 lb.
	2.5%	2½ lb.	40 lb.
	5%	1¼ lb.	20 lb.
	10%	⅝ lb.	10 lb.
Emulsifiable concentrates	1.5 lb./gal.	6⅔ fl. oz.	2⅔ qt.
	2 lb./gal.	5 fl. oz.	2 qt.
	4 lb./gal.	2½ fl. oz.	1 qt.
	8 lb.gal.	1¼ fl. oz.	1 pt.
Wettable or soluble powders	15%	6⅔ oz.	6⅔ lb.
	25%	4 oz.	4 lb.
	50%	2 oz.	2 lb.
	75%	1⅓ oz.	1⅓ lb.

Simple Measuring Table

3 teaspoons (tsp.)	=	1 tablespoon (tbsp.)
2 tablespoons	=	1 fluid ounce fl. oz.)
1 cup	=	8 fluid(ounces
20 fluid ounces	=	1 pint (pt.)
2 pints	=	1 quart (qt.)
4 quarts	=	1 gallon (gal.)
3 tbsp. powder	=	1 ounce (approximately
16 ounces	=	1 pound (lb.)

APPLICATION OF INSECTICIDES

Insects In The Soil

Broadcast soil treatment. Applied to soil surface as dusts, granules, or sprays. May be done in fall, on summerfallow, or just before planting but should be followed immediately by cultivation to a depth of three to four inches. Though more expensive than other methods, this gives satisfactory control for a longer period.

Side Dressings — Recommended for some insects attacking row crops. Apply the insecticide in bands along both sides of the crop row. Liquid, dust, or granular formulations may be used but should be well mixed with the soil.

Band Treatment — Applied as a four to eight inch band along the seed row for root maggots. Liquid, dust or granular formulations may be used and left close to the surface.

Seed treatments—These protect the germinating seed and emerging seedling. A fungicide is often included. Treat seed with commercial preparations of dust or liquid.

INSECTS ON FOLIAGE

Spraying and dusting. For insects that feed above ground, spray with emulsions or wettable powders, or apply dusts. Cover both sides of the leaves and follow all directions on the label. Never spray or dust during a strong wind. Apply at right angles to the wind. This reduces danger to the operator from prolonged exposure to the insecticide.

APPLICATION EQUIPMENT

Low-volume, low-pressure sprayers — These may be used for emulsifiable concentrates but not for wettable powder suspensions.

A conventional weed-spraying boom is effective for broadcast applications. For mature row crops a drop-nozzle boom, such as that used on a potato sprayer, is essential to concentrate the insecticide along the row and to cover under-sides of the leaves. The delivery rate should be approximately five to 10 gallons per acre to ensure proper dispersal.

High-pressure piston-type sprayers — These sprayers are more versatile. They are suitable for wettable powder suspensions that require high pressures to prevent clogging of nozzles. They may be used at lower pressures for broadcast or row crop application. Equipped with spray guns, they are suitable for spraying livestock, barns, corrals, and shelter-belts.

Dust applicators — Dust applicators, power driven, apply dusts uniformly under calm conditions. The efficiency of dusting can be increased, if a canvas sheet is pulled immediately behind the dust boom. The fertilizer attachment on most seed drills may be used to apply dust and granular formulations for soil insects.

Small aircraft — Airplanes are often more efficient and economical — especially if crops are subject to injury by ground equipment. Aircraft sprays are generally fine mists. To avoid losses from drift and uneven coverage, calm conditions are essential. On hot calm days, aircraft sprays are subject to upward air currents, preventing adequate coverage.

Commercial pesticide applicators require a license from the Department of Health.

CARE AND MAINTENANCE OF SPRAYING EQUIPMENT

Check the equipment with water for leaks and clogged nozzles before operation. Breakdowns during operation require repairs to equipment that may contain extremely toxic materials. Some agricultural chemicals are very corrosive to unprotected metals, rubber hose, and hose connections. Insecticide should not be left in sprayers. Wettable powder suspensions are very abrasive and should only be applied with specially designed equipment.

After use spray tanks should be washed out, drained, and dried with the cover off. Drain pumps and hoses to prevent damage from frost. Remove and clean nozzles.

To lessen the danger of herbicide contamination, flush out the sprayer with water. Mix one cup ammonia to three gallons hot water. Leave in the tank for one day and then run it through machine. Wash out sprayer with soapy water and flush again with clean water.

PRECAUTIONS

Insecticides are poisons. Humans and animals can be accidentally poisoned by swallowing the insecticide, by eating insecticide-contaminated food, or by prolonged exposure to dusts or sprays. Continued exposure to small quantities can damage vital organs and accumulate in the fat and milk of animals.

If blurred vision, headache, tightness of chest, or nausea are noticeable after exposure to insecticides, **call a physician at once or take the victim to a hospital immediately.** Be certain what insecticide was used. Take the label of the container to the doctor, as the antidote is listed on it.

Follow these precautions:

1. **Read the label on the container.** This may save your life. It will name the product and its most effective use. It tells how to handle the material and what should be done in case of accident.
2. Wear protective clothing, e.g. coveralls and rubber gloves. Special care should be exercised with concentrates. Respirators or dust proof masks should be worn for volatile materials or extremely toxic dusts or sprays.
3. Remove contaminated clothing as soon as possible and wash before re-use.
4. If pesticides are spilled on the skin, wash immediately and thoroughly with soap and water.
5. Avoid prolonged exposure. Do not inhale sprays or dusts. Smoking (especially hand-rolled cigarettes) should be avoided. All exposed parts of the body should be washed immediately.
6. Do not contaminate food, feed or water. Follow rates of application shown on labels. Strictly observe cautions with regard to the use of treated crops, or crops grown on treated soil.
7. Keep all pesticides in their original containers with proper labels. Store in a safe place away from food or where food is handled. **Keep out of reach of small children.**
8. Destroy all empty pesticide containers by burying deeply or burning. Avoid smoke from such fires.
9. Equipment must be in good working order to avoid leaks and clogging, and should be thoroughly cleaned after use.

MAJOR CROP INSECTS

Wheat Stem Sawfly

Life history. The adults emerge during late June. The female lays her eggs inside wheat stems. The egg hatches into a larva that tunnels inside the stem. In August, the larva cuts the stem at ground level, plugs the upper end of the stub, which remains in the ground, and forms a cocoon in which it spends the winter. The larva pupates in May.

Recognition. The adult, ⅜ inch long, is mostly black, with two pairs of dark colored wings and with yellow bands around its abdomen. The larva is white, with a brown head and a small brown posterior spike.

Infested stems after mid-July contain "sawdust". Sawfly stubs are easily found by pulling up the stubble after the wheat is ripe. Both stubs and stems cut by sawflies have neatly cut ends plugged with "sawdust".

Control. Grow resistant or immune crops. Of the three resistant bread wheats, Rescue and Cypress are more resistant than Chinook, but Rescue has lower quality. All depend on solid stems for their resistance. Prolonged cloudy weather may produce less solid stems and reduce resistance. Barleys and durum wheats have some resistance. Winter wheat may be heavily damaged if late. Crops other than wheat, barley, and spring rye are immune.

Shallow tillage helps. The one-way disc or the discer are the best implements. They must be set to pass just below the crown of the plants to expose the stubs on the surface. Tillage is effective between the first week in May and the first week in June and any time in fall. Burying the stubs is useless unless they are at least five inches below the surface.

If the crop is more than 25 per cent infested, it should be swathed just as the sawflies begin cutting. Infestations are heaviest at the margins. Sawflies, by feeding in the stems, reduce the yield in the infested plants by 10 to 20 per cent. Swathing only prevents part of the damage and does not kill the larvae.

Burning the Stubble is Not Recommended. It does not kill the sawfly larvae and it destroys beneficial parasites. Native grasses are permanent sources of infestation by the sawfly.

Grasshoppers

Recognition and Life History — Three species cause most damage — the migratory grasshopper, the two-striped grasshopper, and the clear-winged grasshopper. They start hatching early in May in a warm, dry year and continue over

a month or more. The young grasshoppers, nymphs, are only ⅛ to ¼ inch long. After growing and shedding their skin five or six times they become full-grown and winged after mid-June. A couple of weeks later they lay eggs until cold weather arrives. The eggs are laid in the upper 1½ inch of soil in pods of 20 to 100 eggs. The number laid depends on weather and food.

A few species lay eggs in early summer, and the late nymphs overwinter. The first warm weather of spring makes them active. These 'hoppers are not injurious to crops.

Natural Enemies—Eggs are destroyed by insects, birds, and rodents. Wasps, ants, beetles, and spiders prey on nymphs. Adults and nymphs are eaten by birds and small mammals. Some are infested internally by maggots of certain flies. A fungus disease is always present and with wet, cool weather can destroy a serious infestation. The dead grasshoppers clinging to the stems of grasses and tall weeds have been killed by this disease.

Where Infestations Arise — The two-striped and clear-winged grasshoppers lay most of their eggs on roadsides, headlands, and pastures and the young nymphs move into adjacent fields. The migratory grasshopper lays its eggs in the previous year's stubble fields. Infestations from flights occur only when the general level of infestation across the prairies is very high.

Crops Attacked — Cereals, flax, and alfalfa are usually attacked. In severe infestation, any crop may be damaged. Tender vegetation is preferred, and the insects move from ripening cereal crops to green flax, winter wheat or cover crops. Adults cause severe damage by cutting off heads and bolls.

Fall Sown Grain and Cover Crops — These are a special problem. A few adults can cause heavy losses. They move from the maturing spring-seeded crops into adjacent seedling crops and back again in the evening. Therefore, poison a strip inside the edge of the maturing crop as well as a strip inside the edge of the seedling crop. Several applications may be needed. Early seeding of the winter crop using a heavier seeding in the outer one or two rounds will help withstand damage.

Control — An annual forecast map is issued showing where precautions may be necessary. Stubble fields should be cultivated in the fall. Spring cultivation is effective in starving young 'hoppers. Do not seed infested stubble fields. Such fields should be worked into narrow "trap" strips that can be poisoned before cultivation is completed. Summerfallow will have practically no eggs.

Poisoning is effective and inexpensive if done early. Watch for young 'hoppers in ditch banks, headlands, pastures, crops in stubble, and crop margins. Poison when nymphs become numerous.

Approved insecticides for grasshopper control are distributed by the agriculture department through municipal districts and counties. Apply to your local municipal office. Follow the label and use the rates recommended. Smaller rates are for young nymphs, the larger for older nymphs and adults.

Treat before bloom or in the evening to avoid hazard to bees. Notify local bee-keepers.

Cutworms

Recognition — Cutworms are the larvae of moths ("millers") seen around lights during the summer and early fall. Cutworms are fleshy, soft bodied worms that curl up when disturbed. Full-grown, they are about 1½ to two inches long. The upper half of the body is darker than the lower, and the backs and sides may be striped.

Life History — Most pass the winter as eggs or partly-grown larvae. Damage is most serious during May and June. They usually feed at night, cutting off plants at the surface. Dry weather during spring and summer favors increase. Under these conditions examine fields frequently and apply prompt control.

Pale Western Cutworm— This cutworm is the most common on the prairies. It is uniform slate-grey with a light yellowish head. On the front of the head are two distinct short black dashes.

The moth flies from about August 10 to September 15 and lay eggs in loose, dusty soil. These hatch early the next spring. The larvae feed on green growth until late in June when they change to brown pupae and later to moths.

Prevent Infestations — Infestations can be prevented by destroying all growth on fallow during late July and leaving undisturbed by tillage or livestock, until after September 15.

Control — Young cutworms can be starved in spring by destroying green growth and delaying 10 to 14 days before seeding. The early growth should be one to two inches high before cultivation. This method is recommended chiefly for stubble fields.

Chemicals may be used before damage is too extensive or just before re-seeding.

Red-Backed Cutworm — This cutworm occurs mostly in parkland areas or occasionally in sugar beets. It is grey on the upper half of the body and has two, broad, dull-red stripes along the back.

Moths lay eggs in late summer and early fall in loose soil. Hatching occurs in spring and the larvae feed as soon as green growth appears. When full-grown, toward the end of June, they pupate and later emerge as moths.

Prevention — Use methods described for the pale western with one notable difference. If a heavy weed growth develops in August, it should be destroyed as moths prefer laying eggs in weedy summerfallow. They also lay in weedy patches in crops.

Control with insecticides is described in the bulletin "Control of Field Crop Insects". (See references.)

Other Cutworms — The army cutworm occurs in southern Alberta and damages cereal crops, mustard, and flax. It is usually dark, olive-green all over, sometimes with two rows of poorly defined creamy spots, or with a dull yellowish-brown band, along the top of the body. Eggs are laid in fall. The larvae feed before winter, and are half-grown by spring.

These cutworms appear quite suddenly in the spring. Early examination of fields is recommended. They complete feeding before the end of May. If crops are seeded early or larvae feed later than normal, they can be controlled with insecticides.

The wheat head armyworm is found on the heads of maturing wheat, and is yellowish with broad stripes.

A variety of cutworms infest gardens and may be very destructive.

Wireworms

Description — Wireworms are hard-bodied "worms", yellowish-white to straw color. They do not curl up when disturbed. Fully developed larvae are ⅜ to one inch in length, have flattened, notched tails. This stage causes the damage. The adults are called "click beetles" because they spring into the air with a click when placed on their backs. No other beetles do this.

Life History — Wireworms take one to over 10 years to develop from egg to adult. In late July or early August, the oldest larvae come up to within two to five inches of the surface and pupate. The pupae change to beetles, which remain in the soil over winter. They appear on the surface as soon as the soil warms in spring. Eggs are laid in May or June.

Early each spring wireworms feed near the surface. As the surface becomes hot and dry, they go deeper. In irrigated lands they feed longer than in dry land.

Distribution — Wireworms are most common in light, well-drained soils. Heavy soils are almost free. Under irrigation, damage is confined to drier knolls and ridges.

Damages — In cereal crops damage is indicated by thin, patchy stands. The entire crop may be destroyed.

Wireworms feed on seeds. Later they shred underground stems but seldom cut them off. These injured plants turn brown and wither. Wireworms also bore into the central shoots of older plants and the tubers, stems, and roots of vegetable crops.

Choice of Crops — Wheat, spring rye, corn, and potatoes are very susceptible. Barley and early-seeded oats are more resistant. Flax may suffer on new breaking, but generally escapes damage, as does winter wheat, fall rye, sweet clover, and alfalfa. Sugar beets can stand thinning without serious loss in yield.

Seed Treatment

Control — Seed treatment of cereals, corn, peas, beans and sunflowers, gives good control. Insecticides can be used alone or with a fungicide. One seed treatment properly applied reduces wireworm numbers so that little damage will occur in three to five subsequent crops. Follow label directions for rates and storage cautions. Do not apply combination dressings to seed already treated with a fungicide.

Use good seed and seeding practices. Avoid very early or very late seeding. Seeding too deeply reduces the effectivness of the insecticide. Recommended farming practices, especially clean summerfallowing, should be carried out. Watch for damage in future crops, and treat again when necessary.

Soil Treatment — Soil treatment is much more expensive than seed treatment, and leaves long lasting chemical residues that may show up in crops for a number of years. It should be used only on soils where damage is known to occur. As outlined under "Insects In The Soil" in previous section, application of insecticide can be done by broadcast, side-dressing or band treatment.

For potato land with heavy infestation, use the broadcast treatment with dusts, granules or sprays and work into top four inches of soil immediately. For lighter infestations, apply insecticide as an eight inch band along the furrow and work in four inches deep, or apply as a side dressing four inches deep on each side of the row. **Do not use or sell tubers or roots from treated fields for livestock feed for at least three years of cropping.**

Use the insecticides and rates currently recommended in Pub. 632 "Control of Field Crop Insects".

Clean fallow every two or three years will reduce wireworm populations. Destroy all green growth during June and July. Do not work deeper or more often than is necessary for weed control.

Reseeding — Reseeding should be done with treated seed where a crop has been destroyed.

Beet Webworm

Primarily a pest of sugar beets, it also feeds on mustard, flax, peas, rape, alfalfa, and weeds.

Description. The larvae on hatching are pale green and about 1/16 inch long. They are on the underside of leaves and hang by threads when disturbed. Fully grown larvae are one to 1½ inches long, olive-green with light and dark stripes. They pupate in the soil. The pupal cases, about one to 1½ inches long, are constructed of silk covered with earth.

The adult is a greyish-brown moth with cream-colored markings on the wings, about ½ inch long with a wing span of about one inch. The moth is triangular and is easily recognized by its short, rapid, zigzag flights. The eggs are pearly-white and disc-shaped.

Life History. In June the moth lays eggs singly or overlapping in rows on the underside of the leaves. Eggs hatch in three to four days. Young larvae eat only the underside of the leaves, but as they grow they eat through and may leave only the veins. They may cause considerable damage in one day.

The second generation, over-winters as pupae. Both May - June and August broods can reduce yield and sugar content.

Control. Check fields during the moth flight for eggs and newly hatched larvae. Control when more than one half-grown larva per leaf is found on 50 per cent of the leaves.

Sugar-Beet Root Maggot

The maggot feeds on the beet root, causing "bleeding" and wilting. Severe infestations reduce yield by three to eight tons per acre. Severest injury occurs in July and early August. Feeding allows root-rot organisms to enter the beet.

Description — The egg is white, slender, and slightly curved. The maggot (larva) is white, without legs, eyes, or a distinct head, tapers toward the front, and is about ½ inch in length. The brown pupal case is oval. The fly is black, about ¼ inch long, with two transparent wings, each with a dark area on the front margin.

Life History — Over-winters as a mature larva, eight to 14 inches in the soil. In early spring it moves to the three to four inch level and pupates. The fly emerges about thinning time and lays its eggs around a host plant. The maggots crawl below the surface. As the soil warms or dries, they move deeper. There is generally only one brood a season.

Control — Seed early in well prepared and fertilized seed bed, followed by adequate irrigation. Crop rotation as well as weed control along field margins and ditches helps. Beets should not follow beets. For chemical control, consult your company fieldman.

Sugar-Beet Root Aphid

Sugar-beet root aphid attacks sugar-beets, table beets, lettuce, spinach, and Swiss chard. The aphid sucks the sap from the rootlets, causes the plants to wilt. Frost damage is more severe on heavily infested plants.

Description — Wingless aphids and a white mold-like substance will be noticed on the roots and in the soil. Late in the season, winged aphids may be found.

Life History — The winter is passed in the soil or as an egg on poplar trees. Crops may be infested from either source. In spring, the aphid forms galls on the poplar leaves. In June and early August, it flies to the beets. In late summer and early fall, the winged forms fly to poplars and give birth to wingless males or females. After mating, one white egg is laid in a crevice in the bark where it over-winters.

Control — Plant early, irrigate early and frequently, and keep soil fertility high.

Rotation is not effective and there is no chemical control. Insecticides destroy the predators that aid in control.

INSECTS IN FARM-STORED GRAIN

Insects will multiply rapidly in moist grain, causing it to heat. Grain that is uniformly dry will not spoil or become infested.

Common pests are the rusty grain beetle, several kinds of fungus beetles and mites. Fungus bettles feed on molds in damp grain and do not attack sound kernels. Larvae of the rusty grain beetle feed on the germ-end of wheat, oats and barley. Mites feed on grain dust and kernels. Grain infested with mites has a musty odor.

Prevention — Prevention is easiest and most economical. The granary should be swept thoroughly and made weatherproof. If the floor and walls are damp, sweep hydrated lime into cracks. Spray all inside surfaces with a recommended bin spray.

Do not put new grain on old grain. New grain contains more moisture than old and will attract insects. Destroy old grain on the ground near the granaries. It usually contains insects. Keep ventilators open during dry weather.

Examine grain every two weeks — Feel with the hand and probe deeper with an iron pipe to detect "tough", damp, or heating grain. During warm weather use cans or cups filled with water and sunk in the grain to within a half inch of the surface, three or four for each granary. Insects are attracted to the water and can be easily seen.

Move and clean infested grain during the winter. Infestations in winter can be controlled by cooling the grain to 25° F. for seven to 10 days. Clean and transfer slowly in thin layers during the coldest weather to piles outside or another granary. Put it through a fanning mill, combine, or threshing machine, or auger it onto a sloping chute fitted with a six-foot section of screen. This will assist in cooling and drying.

Moving and cleaning grain in warm weather often gives satisfactory control when a good job is done.

Fumigation — A fumigant is usually applied as a liquid to the surface of the grain. It forms a poisonous gas that sinks through the grain. Fumigation is most effective on dry, clean grain under warm, calm conditions. Use it in a tight granary or seal the cracks. "Tough", crusted, or mouldy and "hot spots" should be broken up first. Treat "hot spots" by direct application of fumigant through pipes. Before attempting to fumigate, obtain details from your District Agriculturist. **Use of a gas mask is essential.**

Crop	Pest	Description and Control
Forage		
Alfalfa	Alfalfa Weevil	Small, dark brown weevils, over-winter as adults. Lay eggs in stems of new growth. Larvae skeletonize leaves, cause silvery appearance just before first bloom.
Alfalfa	Sweet Clover Weevil	Occasionally attacks alfalfa near newly-cut sweet clover. Adults similar to alfalfa weevil. Cause notching in leaves unlike damage by alfalfa weevil.
Sweet Clover	Sweet Clover Weevil	Small, inconspicuous, dark-grey snout beetle, 3/16 inch long, chew crescent-shaped notches in leaves during whole season. Over-wintering beetles destroy crop as it emerges in spring. Newly emerging beetles in early August destroy seedlings. Seed new stands as far as possible from old. Use shallow tillage in late July, just after removing hay crop, to destroy insects. Much damage attributed to this weevil is actually poor winter survival of the clover.
Grasses	Silver Top	Sterile white heads in bluegrasses caused by a small mite. Control by fall or early spring burning.
Oil Seed		
Mustard Rape	Diamondback Moth	Caterpillars, light green with greenish-brown heads, about ⅓ inch long when mature. Wiggle vigorously and drop on silken threads when disturbed. Similar damage to the leaves as the cabbage worm. Several generations per season. Forms lace-like cocoons attached to leaves.
	Flea Beetle	Adult is small, shiny metallic green to black beetle, jumps rapidly when disturbed. Small holes are eaten into or through the leaves especially on young plants; seedlings may be killed.
	Beet Webworm	See Vegetable Crops.
	Red Turnip Beetle	Up to ½ inch long, red with three black stripes on back. Over-winter as eggs in soil. Small black larvae, similar to those of potato beetle, feed on plants at night.

Crop	Pest	Description and Control
Vegetable Cabbage, Cauliflower, Radish, Turnip, Swede Turnip, Rape	Cabbage Worm	Adult is common white butterfly. Larvae are velvety green caterpillars, up to one inch long, with a faint golden line down the back. Leaves and heads are severely chewed; green to black excrement pellets cling to the leaf surfaces.
Cabbage **Looper**		About the same size and color as cabbage worm; similar damage. It is distinguished by the peculiar looping of the mid-part of the body when it crawls.
Flea Beetles		See Oil Seeds in previous section.
Cabbage Maggot		Adult a grey fly, the size of a housefly; larvae are white maggots that tunnel into the roots causing death of very small plants, especially trans-planted cauliflower; severely damaging the roots of turnips and radish.
Carrots	Leafhoppers	Small, grey-green, wedge-shaped bugs that feed by piercing and sucking plants, and transmit the virus disease, aster yellows. Adults jump and fly readily when disturbed. Disease usually not important in Alberta.
Corn	Corn Earworm	Fully grown larvae green to yellow, usually have conspicuous cream, yellow, brown or black stripes. Larvae feed down the silks and into the tip of the ear. They never bore into the shank.
Corn	European Corn Borer	Larvae uniformly dirty white or pinkish, covered with rows of small brown spots, about one inch long when mature. Chew small holes in the leaves, then tunnel into the stem, causing tassel breakage; tunnel into ear stalks and kernels. Report occurrence to District Agriculturist.
Onion	Onion Maggot	Adult fly resembles the housefly; maggot creamy white, legless, ¼ inch long when fully grown; attacks the root causing young plants to wilt and die. Older plants have bulbs infested and may rot.
Potato	Colorado Potato Beetle	Adults hard-shelled beetles ⅜ inch long, yellow with ten black stripes lengthwise on the wing covers; larvae soft-skinned, hump-backed, brick-red, with two rows of black spots on each side of the body. Adults and larvae eat leaves.
Potato	Wireworm	See previous section on Wireworms.
Potato	Leafhoppers	See carrots, above.
Many Garden Crops		
	Slugs	Soft-bodied, slimy, legless, one inch long, with no obvious head; leave a trail of slime. Young foliage particularly is eaten, almost always at night except when wet and overcast during the day.
	Blister Beetles	Long, narrow, the head distinct from rest of body, strong fliers, active on plants; may be black, grey, brown, or blue, and spotted or striped. Leaves may be stripped rapidly and ragged in appearance.

Crop	Pest	Description and Control
	Aphids	Small, soft-bodied, somewhat larger than a pin head, often clustered in colonies. Most are green, but they may be pink, yellow, black or white. Suck sap of plant, especially growing tips, the leaves may curl and wilt. Some spread virus diseases.
	Cutworms, Grasshoppers, Beet Worm	See respective sections.
Small Fruits		
Currants Gooseberries	Currant Fruit Fly	Small white maggots feed within the berries, causing discolored areas on the fruit and premature ripening. Adults small flies that cluster in bushes just prior to bloom.
Raspberries, Currants, Gooseberries	Imported Currant Worm	Small, spiny, green caterpillars the color of the leaves. Cause tiny holes in the leaves at first, then skeletonize plant.
Raspberries	Raspberry Crown Borer	Adult is clear-winged moth similar to a wasp. The larva spends the first winter in a cell in the soil. Next spring it bores into crown and causes swellings. Prune out old canes close to crown.
Raspberries	Mites	Leaves speckled or blotched with grey patches; often fall prematurely. Mites are extremely small, white to green, on the undersides of the leaves; usually produce a webbing that becomes dusty.
Ornamentals & Lawns		
Cotoneaster Mountain Ash Plum	Pear Slug	Humpbacked, smooth, slimy, black and yellow; resembles a slug but is larva of a sawfly. Eats one surface of the leaves, causes a brown appearance.
	Scale Oyster Shell	Narrow, hard, grey-brown scales, encrust whole areas of the branches. The crawlers are very small, white; will infest the whole tree or shrub.
Lilac	Lilac Leaf Miner	Very small pale green larva with black head, mines in leaves causing brown patches. Also rolls leaf and feeds in roll. Two generations per year. Adult small moth. Spray with malathion or DDT at eight fluid ounces per 40 gals. water.
Gladiolus	Thrips	Very small, slender, brown to black, 1/16 inch long. The young are yellowish-green. Feeding causes silvery streaks on the blossoms, spikes may be deformed, attack corms.
Roses	Rose Weevil	Dark red or red and black weevil, bores holes into centre of rose buds so that no flowers are produced.
Virginia Creeper	Leafhopper	Small, narrow, very active, pale yellow to white; feed on the undersides of the leaves. Leaves have small, white feeding scars; eventually turn white and drop.
Turfgrass	Earthworms	Earthworms in lawns are purplish with flattened tail, grow to over eight inches long. Leave casts on surface and make turf bumpy. Use ¼ lb. actual chlordane or 10 lbs. lead arsenate per 1,000 sq. ft. Water heavily after either treatment.

Crop	Pest	Description and Control
Turfgrass	Sod Webworm	Larva of lawn moth, causes irregular brown patches. Grass dies back, easily pulled out. Larva slender, grey with brown head, about ½ inch long, found under dead sod. Treat with three tbsp. 40 per cent chlordane W.P. in one gallon water per 1,000 sq. ft. of turfgrass.
Trees		
Spruce, Pine, Tamarack, Balsam	Aphids	Clusters of small, soft, brown, green, or black insects on trunks, branches, or twigs or amongst distorted needles at the tips of twigs. Spray trees thoroughly with malathion.
Caragana, Maple, Elm, Ash, Poplar, Willow, Fruit trees	Aphids	Leaves curled or discolored by small, soft insects that cluster on trunks, branches, leaves, or seed pods. Spray trees thoroughly with malathion. For those types that roll or curl leaves, e.g., elm, spray as early as possible.
Caragana, Ash, Lilac, Honeysuckle	Blister Beetles	Blossoms and leaves devoured by swarms of large, active beetles. Dust beetles with rotenone or DDT, or spray with chlordane.
Willow, Poplar	Borer (Weevil)	Tunnels throughout lower stem. Dead patches of bark, moist sawdust mixed with fine splinters around infested areas. Larva is yellowish, fleshy, footless grub with distinct brown head. Remove and burn all badly infested limbs and trees. Spray or wipe a penetrating oil emulsion on affected parts of tree during first warm weather in spring.
Manitoba Maple	Cankerworm	Small holes appear in leaves; later, foliage destroyed by brownish-green caterpillars that spin silken threads. Present in May and June. Spray with DDT.
Spruce, Fir	Cooley Gall Aphid	Feeding causes formation of cone-shaped galls on terminal twigs of spruce. Pick galls when green and burn. Spray with malathion at the time buds break in the spring.
Willow, Poplar	Leaf Beetles	Leaves skeletonized by small groups of black grubs, causing scorched appearance or leaves consumed by small to medium multi-coloured beetles. Dust or spray with DDT.
Spruce, Pine	Pine Needle Scale	Yellowish mottling of needles caused by small, waxy, white, elongate scale insects; present on the needles all year. Spray with malathion in first week of June, and again in second week of August.
Spruce, Larch	Sawflies	Needles eaten by small green, brownish, or greyish-green "caterpillars" with shiny red or black heads; on spruce in June; on larch in July. Spray with DDT, chlordane, or malathion.
Spruce	Spruce Needle Miner	Larvae mine and web needles to form mat of dead needles and grass. Infested branches are unsightly. Larvae hibernate in hollowed-out needles attached to the stem. Spray with DDT in early summer. Wash trees thoroughly with water under pressure (garden hose).

Crop	Pest	Description and Control
Spruce	Spruce Spider Mite	Yellowish mottling of needles with fine, silk webbing around twigs between needles; mites almost too small to be seen. Present from early May to end of season. Spray with Kelthane or malathion in second week in May and again about mid-June. Water under pressure is also useful to wash mites away.
Poplar, Willow, Fruit trees	Tent Caterpillar	Leaves eaten in May and June by dark, hairy caterpillars that cluster around stems and branches. Caterpillars may not make a tent. Cut out and destroy tents during cool weather or at night. Dust or spray with DDT, derris or malathion.
Poplar, Ash, Birch, Pine, Spruce	Wood Borers	Trees or branches weaken and die; larval galleries extend throughout the stems and branches or just beneath bark; sawdust may be emitted from exit holes; whitish larvae of various sizes present year round. Prune and burn infested wood and branches. Lindane or carbon tetrachloride useful when squirted into gallery and opening capped with putty.

For further information on shelterbelt and forest pests write to the Forest Research Laboratory, 721 Public Building, Calgary, Alberta, or Field Crops Clinic, Alberta Department of Agriculture, Edmonton, Alta. Send samples of insects and damaged plants.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Control of Field Crop Insects	632	632
Grasshopper Control in Alberta	145	622-4-1
Control of Garden Pests	130	625
Control of Insects of Ornamental Trees, Shrubs, and Shelterbelts	41	627
Canada Department of Agriculture		
Control of Grasshoppers in the Prairie Provinces	1036	622.4
Pale Western Cutworm Control	1109	622.6
Insects and Mites in Farm-Stored Grain in Western Canada	1131	623-4
Control of Field Crop Insects	——	632

LIVESTOCK

INTRODUCTION

Livestock production makes up a major source of Alberta farm income and an indispensable part of balanced agriculture, permanent soil conservation and efficient land use. Significant advances have been made in recent years in breeding, feeding and management practices in order to cope with the changing economic situation. These advances have generally been associated with greater specialization.

While specialization varies in degree of intensity, it has generally resulted in more efficient production. Individual producers or feeders can no longer ignore these advanced methods and the degree of specialization necessary to compete with other producers in their own field.

Breeding, feeding and caretaking form the basis of livestock production. General principles applicable to all classes of livestock are set out herewith. It is well to understand these principles before undertaking a study of details.

SELECTION AND BREEDING

Consistent selection is the key to success in the genetic improvement of livestock. Only by culling inferior individuals and retaining superior ones will progress be ensured.

Superiority must be measured in terms of economic worth. This includes weight for age, milk production, dependable reproductive performance and market suitability. Show ring standards tend to place undue emphasis on points other than performance. Livestock producers must seek other measures of economic worth in their selection programs.

OFFICIAL TEST RECORDS

The provincial and federal departments of agriculture have made livestock testing programs available. The record of performance policy for swine is an excellent guide to selection for rate of grain, feed conversion and carcass quality. Consistent use of R.O.P. records in boar selection is strongly recommended. For dairy cattle, R.O.P. and Dairy Herd Improvement Association tests supply information on milk and butterfat production that is invaluable in the selection of breeding stock. The federal-provincial R.O.P. policy for beef cattle, inaugurated in 1959, is designed to provide information on rate and efficiency of gain for this class of stock.

The value of progeny testing for cattle is somewhat limited since large numbers are required for accuracy. Therefore, breeders other than those using A.I. should base their sire selection program on performance. It is desirable for those using A.I. to base sire selection on progeny information.

PRIVATE HERD RECORDS

Private records maintained by the breeder complement the official testing program. Such records often constitute the only basis for intelligent culling and replacement of breeding females. This is true for the commercial producer as it is for the breeders of purebreds. Minimum records consist of details of reproductive performance and mothering ability for each breeding female. To this should be added information on the vigor, growth, and market performance of the progeny together with details of any defect such as dwarfism, ruptures, ridgelings or intersexes (hermaphrodites). Families with inherited defects should be avoided.

APPRAISAL OF THE INDIVIDUALS

Selection is completed by appraisal of the individual. Vigor, weight for age, strength of feet and legs and mammary development are important. Number of teats has particular significance in swine and should be sought in the boar as well as the female.

In comparing animals from different herds, it is best to compare each animal with respect to its own herd average. Real genetic improvement can be expected only if the animals are well above average in the desired traits.

MATING SYSTEMS

The mating system will depend upon whether the progeny are intended to be purebred seed stock or market animals. Producers of purebreds should use mild inbreeding or line breeding to promote genetic purity. This will permit

greater accuracy in culling and will tend to develop a prepotent or true breeding line. When herd performance is high, inbreeding may become a necessity to avoid introducing stock of lower genetic worth.

Producers of commercial stock have the choice of cross-breeding or grading-up. Crossbreeding utilizes sires from two or more breeds while grading-up requires sires of one chosen pure breed. Either system will work well provided that selection is consistent and rigorous.

The popularity of crossbreeding is due mainly to the increased vigor and growth in crossbred animals. Full advantage of hybrid vigor is unlikely to be realized unless the crossbred female is used for breeding. This is particularly evident with pigs for which the increased vigor of the hybrid dam can contribute materially to improvement in litter size and survival. Continuous crossbreeding to yield satisfactory results must be well planned in advance and the plan must be followed in detail.

Crossbreeding is not a cure-all for production problems. It may increase productivity if used in conjunction with but NOT as a substitute for good feeding, management, and sanitation.

The grading-up procedure will not provide as high a level of vigor as is obtainable from a good crossbreeding program. However, it is considerably simpler in application than a planned crossbreeding program, since it presents no problems in breeding of replacement females. For this reason, it may be preferable for small herds.

No breeding system will succeed unless based on sound selection. The choice of breed or breeds is secondary to the choice of the individuals which form the herd. Successful purebred or commercial breeding must utilize top quality purebred sires in every generation with selection, generation after generation, based on official as well as private records.

ARTIFICIAL INSEMINATION

Much of the guess work can be taken out of a breeding program through artificial insemination. By contemporary comparison method, dairy sires are identified according to their ability to transmit both milk production and type characteristics. Beef sires are selected on the basis of their own performance and to some extent progeny testing.

The dairyman, by using substantially plus proven sires, can realize continued genetic improvement in milk production. The beef operator can realize substantial increases in weaning weights, feed lot gains and feed conversion through selection of A.I. sires of known high transmitting ability for production traits. Such progress is attainable at a cost competitive with natural breeding. The breeder should understand sire proof information and make his selection accordingly because a wide range of variability exists between sires available through any A.I. service.

Other advantages of an A.I. program include minimizing the spread of venereal diseases, eliminating the danger of bull handling, a wide choice of breeds, facilitating crossbreeding, and encouraging cow identification and setting up of herd records.

The chief disadvantage of A.I., particularly with beef herds, is additional labor and inconvenience required to detect heat. An A.I. beef operation must have a pasture free of bush with enough grass to carry the breeding herd for 30 to 40 days. Clean up bulls are usually used for the remainder of the breeding season. Success of a beef program depends on the number of cows suitable to breed in a specified period, heat detection and fertility level. Many beef operators might consider servicing heifers artificially, thereby allowing an extra crop of calves from the herd sire.

Fertility level with A.I. is equal to natural breeding. However, there is a wide variation of fertility level between herds.

Primary factors effecting fertility are:

(a) nutrition with emphasis on Vitamin A, phosphorus, and energy,
(b) care and sanitation at calving,
(c) freedom from venereal diseases,
(d) allowing about 60 days after calving before breeding,
(e) service from middle to late heat,
(f) a well-qualified and experienced A.I. technician.

An A.I. service is now available in most areas of Alberta from local inseminating businesses, which are licensed under both federal and provincial regulations. A farmer inseminating his own cows does not require a licence. Producers of purebreds should acquaint themselves with the rules of their own breed organizations concerning the registration of animals conceived artificially. For further advice concerning artificial breeding contact the local A.I. unit serving your district or the Animal Industry Division, Alberta Department of Agriculture.

NUTRITION

The function of livestock on Alberta farms and ranches is to convert grain and forage crops into concentrated and highly palatable, protective human foods. Within limits livestock can convert inadequate rations into milk, meat, work or wool, but feed is wasted and cost of production increased when livestock are forced to make do with something less than a balanced ration.

Feed is the largest single item in the cost of producing livestock. Most of the nutrients required are present in the basal feeds — roughage and grain — but **not** in the proportions required by the animal. Thus profits are in large degree dependent on the producer's knowledge and the extent to which he applies his knowledge of :

(a) the nutrient requirements of his animals at all stages of the life cycle.

(b) the nutrient properties of the basal feeds.

(c) ways and means of supplementing the basal feeds to make rations nutritionally complete at minimum cost.

Study of Table I in relation to the following comments will give a working knowledge of the above three factors and furnish reasons for recommendations in the sections that follow.

TABLE I

Approximate Levels of Some Important Nutrients in Common Feeds and Range of Levels Required in Rations

	DE kcal. per lb.	Protein(1) %	Ca %	P %	Per lb. of Feed Carotene mg.	Vitamin A I. U.
Oats	1400	11 (8-15)	0.09	0.35	0	0
Barley	1500	11.5 (8-16)	0.06	0.40	0	0
Wheat	1600	14 (8-17)	0.04	0.40	0	0
Legume hays	950	14 (8-16)	1.4	0.23	2–20	0
Grass hays	900	7 (4-12)	0.34	0.15	2–15	0
Straws	850	4 (1- 5)	0.24	0.09	0	0
Vegetable protein meals	1400	37 (20-50)	0.32	0.75	0	0
Animal protein meals	1300	55 (40-75)	8.0	4.3	0	0
Range(2) of levels required in rations for :						
Beef cattle(3)	950–1350	7.5–12.5	0.15–0.37	0.15–0.28	1.9–3.8 or	750–1500
Dairy cattle(3)	950–1400	7.5–15.0	0.15–0.50	0.15–0.40	1.9–3.8 or	750–1500
Sheep	1000–1250	7.0–12.0	0.15–0.30	0.14–0.22	0.4–1.9 or	200– 750
Swine	1350–1600	13.0–22.0	0.50–0.80	0.40–0.60	1.2–3.0 or	600–1500

(1) The bracketed figures indicate the range of protein levels that may exist in grains and roughages of the same general description, and in protein meals of different types. Similarly levels of other nutrients may differ markedly from the average values for a given kind of feed. See page 227 re services available for analysis of farm-grown feeds.

(2) In general, the younger the animal and the higher the rate of growth or production desired, the higher the levels of nutrients required.

(3) Over 400 pounds live weight.

DIETARY ESSENTIALS

Water

Water is a very important nutrient and is required in quantity by all livestock. Efficiency of production is lowered if for any reason animals consume less than enough. If the quality of the water is in question, forward a one-quart sample to the Provincial Analyst, Edmonton, for analysis.

Energy

Carbohydrates, mainly starches and celluloses in grains and roughages, and fats are burned in the body to provide energy. Surpluses build new body tissues, chiefly fat. Surplus protein can be used for the same purpose but the real function of protein is to provide the building blocks for new body or milk protein. All the basal feeds and supplements used in livestock rations furnish energy, but the levels as well as the cost of energy vary appreciably between different types of feeds.

In earlier feeding standards, energy values were usually expressed as pounds of total digestible nutrients (TDN) per 100 lb. of feed, but they are now more frequently expressed as kilocalories (kcal.) of digestible energy (DE) per lb. of feed. Two thousand kcal. are equivalent to one pound of TDN. Approximate DE values for some common feeds and ranges in DE requirements for different classes of livestock are listed in the second column of Table I.

Bear In Mind

1. Lack of sufficient energy is a common deficiency in livestock rations — for ruminants one of the commonest.

2. Rations deficient in energy are frequently deficient in palatability and in protein, minerals and vitamins.

3. The inherent will to live compels livestock to try to eat enough of even the most unpalatable and unbalanced rations to maintain body heat and essential body functions.

4. It is only from feed beyond the maintenance level that livestock produce anything for their owner. This means that if an animal requires nine pounds per day for maintenance, and the quantity consumed is 10 pounds, the animal will produce something for the owner for **one-tenth** of the feed. If the quantity eaten is 18 pounds, **one-half** of the total feed will go into something that the owner can sell.

5. Roughage feeds, other than lush pasture, are, even for ruminants, too bulky and too low in DE content to provide for much beyond maintenance needs.

6. Other nutrients are required in specific ratios to energy. Thus, in general for any given class of livestock, the amounts of other nutrients per pound of ration should be increased as the DE per pound of ration increases.

Proteins

With the exception of ruminants which can utilize some non-protein nitrogen from compounds such as urea, animals can build or replace body proteins only from dietary proteins. Protein deficiency is very common in livestock rations.

Bear In Mind

1. Protein is required in amounts varying from seven to 18 per cent or more of the total ration. The percentage necessary is highest during the more rapid stages of growth or production. Protein needs are higher for fast than for slow growing species.

2. It is apparent from Table I that:
   (a) cereal grains do not contain sufficient protein for pigs;
   (b) low grade roughages frequently contain insufficient protein to meet even maintenance requirements of ruminants;
   (c) rations composed of average grain and good legume hays are likely to contain sufficient protein for beef cattle and sheep and to require relatively small additions of protein for dairy cattle.

3. Quality of protein is important for single-stomached animals, but less important for ruminants.

4. Compare prices of protein supplements on a basis of **cost per pound of protein — not** on a basis of price per 100 pounds of supplement.

Minerals

1. **Common Salt** — All feeds of plant origin are deficient.
2. **Calcium (Ca) and Phosphorus (P)**
   (a) Ground limestone is a cheap and effective source of calcium, but **it does not contain phosphorus.**
   (b) If P is required, a supplement containing 11 per cent or more of P should be used. With few exceptions, such supplements contain more Ca and P even without the addition of ground limestone. Good P supplements are justifiably more expensive than ground limestone.
   Price per 100 pounds of supplement can be very misleading. From the guarantee on the container calculate what you are paying for a pound of P. If the price is $6.00/cwt. and the product contains 15 per cent P, the cost per pound of P is 40¢; if the price is $4.90 and the P content seven per cent, you pay 70¢ per pound for P. If the product contains common salt, calculate how much you are paying for salt.
   (c) Note from Table I that grains are very deficient in Ca, but are fair sources of P. Legume roughages are rich in Ca. All roughage feeds tend to be deficient in P. Mature or weathered roughages are likely to be seriously deficient in this important nutrient.
3. **Iodine** deficiency is very common in Alberta feeds.
4. **Cobalt** deficiency may be a problem in rations for ruminants.
5. **Iron** deficiency is seldom a problem except in suckling pigs.
6. **Zinc** — See "Swine" — zinc supplements are not recommended for other farm animals.

BEWARE

1. Periodically supplements (mineral, vitamin, protein, or a combination) for which claims are made which can't be backed up by facts, are sold to farmers at high prices. Calculate what you are paying for nutrients of established nutritional value; for example, see 2 (b) under "Calcium and Phosphorus".

2. If a ration is deficient in protein, NO mineral or vitamin-mineral mixture will replace a protein supplement. **Calculate whether the salesman's "Product X" will, if fed at the level recommended, balance your ration at least cost.**

3. Consult your District Agriculturist.

VITAMINS

Vitamin A

(a) Deficiencies of this vitamin are common in Alberta.

(b) Requirements are proportional to body weight; they are higher for lactating animals and during the last one-third of pregnancy than at other stages.

(c) Green feeds contain carotene which is converted into vitamin A by animals, but carotene is quite unstable and easily destroyed by exposure to air, heat, light or minerals so that green color is not a guarantee of high carotene content in stored roughages. Vitamin A also is unstable and subject to destruction under the same conditions as is carotene.

(d) Grains contain no carotene; brown or black silages, weathered hays, straw and winter forage contain little or none.

(e) Buy carotene or vitamin A supplements from reputable sources. Calculate cost on a basis of cost per milligram (mg.) of carotene or per million international units (I. U.) of vitamin A — **not** on a basis of price per pound of supplement.

Vitamin D — This vitamin is required for the formation of bones. There is no vitamin D in grain and comparatively little in most other farm-grown feeds. Direct sunlight, acting on substances in the outer coat of livestock, forms vitamin D. Guard against vitamin D deficiency (rickets) especially in all young animals that receive limited or no exposure to direct sunlight.

Other Vitamins — Deficiencies of other vitamins in rations for cattle and sheep are possible but not probable. Supplementation with vitamins other than A and D is recommended only under special circumstances. See page 148 for vitamin supplementation of rations for young pigs.

Borderline Deficiencies Often Go Unnoticed But Are The Major Cause of Loss

Economic losses due to **borderline** nutritional deficiencies are much greater than those attributable to **marked** or **complete** deficiencies. The effects of extreme deficiency in even one nutrient are so apparent that correlative measures are usually applied. Symptoms of borderline deficiencies are not dramatic and tend to go undetected. Inefficient use of feed, slow growth and fattening, low milk production, poor reproduction and high susceptibility to disease tend to become accepted as normal. The cumulative economic loss to the livestock industry is staggering.

MANAGEMENT

Management entails the decision making process and action program which determines the place of livestock in the general farm operation. It then applies the knowledge of selection, breeding, feeding, general care and marketing that is accumulated through research and experience. Sound managment requires planning to attain maximum reproduction, survival of offspring, utilization of feeds and minimum loss from parasites and disease.

Efficient operations may vary considerably depending on such factors as location and size of farm, available labor, degree of specialization, feeds most commonly available and local market conditions.

Variation in management practices are largely due to degree of specialization rather than to deviation from well-established principles. The present trend to specialization is generally associated with enlarging operations to minimize overhead costs and maximize labor efficiency per animal unit. Management becomes more critical under such arrangement because of increased investment and the increased concentration of animals.

Livestock management tends to suffer where too many enterprises are carried on the same farm. It is difficult to have an up-to-date knowledge of each, to provide the necessary equipment, and to use labor to best advantage. Continuity from year to year in one livestock enterprise offers the best opportunity for gaining the necessary knowledge and experience and to avoid the waste from frequent changes of breeding stock and equipment. The main basic factors in livestock management are as follows:

1. **Feeding** — Feeding involves time and labor. Take advantage of every possible labor and time saving device. Regardless of the size of the operation, consideration of location of equipment, bedding and water can greatly reduce chore time. Feed and labor are two main operation costs in livestock production. Efficient use of both can reduce cost per unit or per animal.

2. **Housing** — Housing varies from fairly simple for beef cattle and sheep to more costly for dairy cattle and hogs. It must provide adequate protection from cold, proper ventilation, ease of cleaning, convenience in location and layout. Construction should be of the cheapest possible design and materials. However, the material should be reasonably long-lasting.

3. **Equipment** — Fences, pens, gates, chutes, squeezes and hurdles are essentials in handling stock with dispatch and satisfaction. Lack of this equipment results in wasted time and neglect of necessary practices and treatments.

4. **Comfort of Animals** — Animals react favourably to comfortable surroundings. Ample bedding during cold weather and shade during hot weather more than pay for the cost.

5. **Breeding** — Time of breeding should permit birth dates to coincide with weather, housing or other protection available, advantage from seasonal markets, and distribution of available labor.

6. **Care Previous to Breeding** — Breeding females are more productive when in moderate condition, on a well balanced diet and gaining in weight when bred.

7. **Care During Gestation** — Pregnant animals should have ample exercise. Special attention to diet is necessary to assure strong offspring at birth.

8. **Care at Birth** — Profit or loss may depend on the degree of care at this time. Special attention is doubly important to ensure that young animals survive the first few hours.

9. **Creep Feeding** is important to supplement milk supply, increase gains during the nursing period and reduce the degree of change at weaning time.

10. **Weaning** — Ages and methods may vary considerably but this should be recognized as a critical stage in any animal's life and should be done with a minimum of stress.

11. **Treatments and Operations** — (a) Cattle—Identification (tattoo, ear tag, branding); castration, dehorning, warble control treatment, louse control and foot trimming.

(b) Swine — Clipping eye teeth from piglets without injury to the gums or mouth, identification (tattoo, ear tag or ear notching), iron for suckling pigs, castration, segregating for uniform size in feeding groups, detusking aged boars, foot trimming of sows.

(c) Sheep — Crutching ewes before lambing, attention to acute udder inflammation, mothering up lambs, identification (tattoo, ear tag, ear notching, fleece branding) docking and castration of lambs, shearing, proper care and packing of fleeces, dip or spray for external parasites, drenching for internal parasites predator control measures as necessary, special attention to udders, mouths and wool when culling out ewes, foot trimming of ewes.

12. **Disease Prevention and Control** — Sanitation of premises, rotation of pastures and restricting visitors from feeding pens. Some diseases can be controlled by vaccines. In these cases, vaccination should be standard practice. (See Veterinary section.)

13. **Parasite Control** — Sanitation of premises and pasture rotation are leading factors. Parasite control measures should be routine with sheep husbandry. (See Veterinary section.)

14. **Records** — Herd performance and accounting. Evaluating the performance of animals in a herd or flock can only be done if certain minimum records are available. Factors here are: identification, rate of gain, feed consumption and quality of product.

Only by accounting can the operator determine the value of his livestock enterprise in relation to his combined farm operation. (See Agricultural Economics section.)

15. **Marketing** — Marketing systems are highly complex and not generally well understood by primary producers. As marketing is the final step in management, and price is the factor most likely to determine profit or loss, selling to advantage requires some study of markets.

Two main divisions are usually available — the central market and the local market. The central market usually reflects a truer picture of supply and demand throughout the nation, particularly with respect to finished livestock. The local market has the advantage of less transportation cost, but should be judged by the competition present. The rapid progress made by auction selling has been possible because producers desire to see open competition for their product.

Producers are cautioned against selling locally on one bid unless they are thoroughly familiar with central market quotations and freight differentials. They are also cautioned against allowing transportation agencies to do their selling. (See Agricultural Economics section.)

BEEF CATTLE

Beef cattle production is a relatively low profit agricultural enterprise. Therefore, it is especially important for cattlemen to adopt new practices that will yield an increased return on their investment. New management and feeding practices provide a rapid means of improving profit. Improvement through breeding accumulates slowly. To maximize profit, cattlemen should provide breeding stock with superior genetic merit for performance with a suitable environment to express their production potential.

MANAGEMENT

Major beef cattle enterprises are :

1. Seed stock production.

2. Cow-calf, feeder production maximizes roughage utilization and is best suited to non-arable grazing land.

3. Combination farm production and finishing utilizes considerable grain and depends upon having grazing land for the cow herd that produces feeders. Cattlemen with cow-calf operations are expressing growing interest in retaining ownership of their calves to market weight in custom feedlots. They want to take full advantage of the performance improvement they have "built in" to their calves through selection and crossbreeding.

4. Feedlot finishing of feeders maximizes the utilization of grain. Under present conditions, it is the only beef cattle enterprise likely to produce satisfactory returns on high-priced arable land.

An enterprise of sufficient size should be developed to make efficient use of resources invested in land, labor, and facilities. The owner should maintain a critical business analysis to determine what new practices would increase long term profits.

Calving

Calf as early as available protection and management procedures will permit. Calves born ahead of the grazing season will make better use of dam's milk and grass. Early calves will weigh more at conventional weaning times.

Timely attention at calving is the "pay off" of a year's work. Early calves are more likely to be dropped in a restricted, protected area. Therefore more care is required to minimize disease. Calves should be moved away from the calving area soon after birth to limit build-up of the killer microbes of scours. Separate early and late calving cows after calving to restrict transmission of any contagious diseases.

Dehorning

Dehorn young calves by the following methods:

1. Birth to two weeks (most easily handled)—caustic paste or pencil.
2. Birth to six weeks — electric dehorner.
3. Two to three months — tube dehorner, knife, caustic pencil; hot iron is often used at branding time.

Castrating

Castrate early — Commercial calves should be castrated before weaning. The knife is the only sure instrument for all ages. If the Burdizo is used **it must be used with care** to insure that the cord is fully crushed. This will avoid staggy steers.

Identify Calves

Identify young calves with an ear tag or notch for effective calf selection and cow culling.

Weaning

Minimize weaning stress on calves. They are shrunk out and susceptible to diseases that can cause heavy losses. Wean on grassy areas that generate less dust. Calves going on feed immediately after weaning adjust to feedlot conditions easier if they have been creep fed long enough to eat grain readily.

Test cows for pregnancy at weaning. This permits cattlemen to appraise herd fertility and cull open cows before winter feeding begins.

Give timely attention to parasite and disease control.

EARLY BREEDING

Breed heifers as yearlings provided they weigh 600 pounds at the beginning of the breeding season:

1. A majority will be cycling regularly and a higher percentage should conceive early in the breeding season.
2. Their subsequent growth on range should assure that they will be large enough to calve at two years with limited difficulty.
3. Their early calving as two-year-olds give them more time to recover prior to breeding season. Thus the frequency of open three-year-olds can be substantially reduced.
4. After weaning their first calf, heifers should be segregated from mature cows and given additional feed during the winter to assure continued growth and strength for second calving.

Breeding bulls should be well exercised and conditioned but not over-fat when they are turned with the cow herd. Do not use bulls until 15 months of age and then only on 15 to 20 cows. The number of cows per mature bull during a normal breeding season is somewhat dependent on the nature of the area and the management of the herd. The following is a guide:

Hand mating, 60.
Farm pastures, 40.
Open range, 30.
Rough range and bush, 20.

Housing—Brush shelters, deep coulees, or board fences are usually adequate for all classes of cattle in the southern chinook area. In the northern area bush shelters and board fences will prove adequate for mature cattle. However, young stock should be afforded the protection of open front sheds.

BEEF CATTLE BREEDING

Gradual, but continuous improvement in potential herd profit is possible through consistent application of sound animal breeding principles to cattle production. Seed stock breeders have the responsibility for improving the basic germ plasm. Commercial cattlemen can purchase breeding stock from breeders who are doing the best job of continually improving economic traits.

SEEDSTOCK BREEDING

Future success of a breeder's program will depend upon how well the progeny of his breeding stock perform for commercial cattlemen. Breeding herds should be maintained and selected under the conditions in which their commercial progeny will have to perform. The basis for improving the profit making ability of a breeder's herd is a sound record of performance selection program. Growth rate is favorably associated with the most important economic traits of beef cattle. Fast growing heifers reach puberty earlier and calve more easily at two years. Fast growing calves are more efficient in the feedlot.

Weight Selection — Select for weight at standard ages:

1. **Weaning** — By adjusting for age of calf and age of dam, it is possible to select accurately for dam's milking ability.
   Cull out and castrate 20 per cent of the bull calves with the lowest adjusted weaning weights. This will begin selection pressure for dam performance and reduce sorting and selection work when bulls are yearlings.

2. **Yearling** — Weights are usually adjusted to a 12-month or 18-month basis. More breeders are selecting bulls for growth rate on a high plane of nutrition to 12 months because an increasing percentage of feeder cattle go on feed immediately after weaning. Heifers can be grown out more slowly and selected for high 18 months weight.

Operational aspects of selection — Cattle can be selected for yearling weight only. There is a favorable correlation between weaning weight and yearling weight. Thus, selection for both milking ability and the calf's own growth potential is possible through selection for **one trait.**

Some breeders breed up to 80 per cent of their yearling heifers, test for pregnancy in the late fall, then **select among pregnant heifers for yearling weight.** This practice emphasizes reproductive performance immediately.

A seed stock herd can be improved by selecting the great majority of replacement bulls and heifers from within the herd. Breeders with complete herd records can make more accurate selection from their own stock than from other herds. No less than three-fourths of the sires used in seed stock herds should originate from that herd. Outside sires should be introduced cautiously. Select

4. Select crossbred heifers for growth rate and mate them continually to bulls of breed B.
   (a) If two breeds are used, breed selected B X A crossbred heifers to breed A.
   (b) If three breeds are used, breed selected B X A crossbred heifers to bulls of breed C.
5. The producer continues the same system indefinitely, always selecting the best performing replacement heifers and breeding them to the breed of sire in the program to which they are **least related.**

Specific Three Breed Crossing

1. Select three breeds for crossbreeding. Select two breeds (e.g., A and B) that will produce a crossbred brood cow with high fertility and milking ability. Select a third breed (breed C) with superior postweaning growth and carcass characteristics.
2. Locate reliable sources of A X B crossbred heifers from producers using performance selected bulls. Gradually replace the existing cow herd with purchased crossbred females to be used as brood cows as long as they are productive.
3. Breed the A X B females continually to bulls of breed C.
4. Market all calves.

Rotational crossbreeding permits the producer to select his own females which he must develop for breeding. It also requires identifying the sire of each heifer by ear tag or hide brand to assure systematic breeding. It is easiest to keep rotational crossing systematic in large herds or through use of artificial insemination.

Specific crossing permits commercial cattlemen to specialize in market calf production and creates another specialized business of producing crossbred breeding heifers. Breeds can be used in a program according to their superiority for either maternal or growth traits. The crossbred market calves produced are of the same breed proportions each year. Under natural service a selected bull battery can be used until "worn out".

Herd Depends on Bull

Future performance potential of a commercial herd depends on the genetic merit of the sires used. Commercial cattlemen cannot afford the luxury of a poor performing bull. The bull can be marketed after his first progeny are evaluated but the cowman may have to use some of his heifers (though inferior) for several years.

Performance Selection

Locate breeders practising performance selection. Purchase bulls with the highest performance records obtainable. Price may be the governing factor. Commercial cattlemen cannot afford to support seed stock herds that are unable to provide complete adjusted records on weaning weight and postweaning gain of bulls offered for sale. If artificial insemination is used, select bulls from the sire battery with the best progeny test for both weaning weight and postweaning gain.

FEEDING

General considerations in the feeding of livestock have been outlined under Nutrition.

Factors that require special attention in feeding beef cattle are :

Energy — Mature range cows require about 15,000 kilocalories of digestible energy per day under mild winter conditions and 18,000 kilocalories per day under cold winter conditions. If a cow enters the winter period in good condition, she may lose 100 to 200 pounds weight without harmful effects. However, excessive loss of condition is undesirable because she may become a "downer" and die just prior to calving. Replacement heifers and calves should receive enough energy to gain about one pound per head per day.

Fattening stock should be fed all the energy they will consume. Finishing rations are characteristically high grain, low roughage rations. The energy concentration should not exceed about 1450 kilocalories of digestible energy per pound. Consumption of higher energy rations is reduced so that gains are lower.

Protein supplementation — This will depend on the main parts of the ration. Dried range grasses and straw are low in protein and their digestibility is increased by a protein supplement. Legume hays are relatively good sources of protein. When fed liberally, there is little need for supplementation.

Mineral — These supplements are required by all classs of beef cattle. Sodium chloride (common salt), phosphorus, calcium, cobalt, and iodine are the only minerals that are likely to be deficient. These should be fed the year round. Phosphorus supplementation is especially important for range cattle and a 50 : 50 mixture of salt and high phosphorus supplement should be provided free choice. Provide cattle on a heavy grain ration with a mixture of 40 per cent salt, 40 per cent phosphorus supplement, and 20 per cent ground feeding limestone. About 1/10 pound of mineral per head per day can be incorporated with grain when fed.

Vitamin A — This is the only vitamin likely to be lacking. Supplemental Vitamin A should be provided except when cattle are on good green grass. A 500-pound calf for replacement or fattening should receive 10,000 international units (I.U.), a 750-pound yearling 15,000 I.U., a pregnant cow about 30,000 I.U. per day. After calving, a cow should continue to receive Vitamin A for a month or until she goes out on green grass.

Vitamin A can be supplied mixed with feed, injected, or mixed with water. If it is mixed with feed, use a gelatin coated product and keep it dry at all times. If it is mixed with salt or mineral, mix at frequent intervals, about two to three weeks, and keep the mixture dry.

Feed additives — These have become a part of beef cattle rations, particularly feedlot finishing rations. However, if they are to serve their intended purpose, they must be used properly. These are not nutrients and are often very powerful in their effect on the animal. Always administer according to the manufacturer's instructions.

Sex hormones are used in the last three to four months of the feeding period. The cattle should be on full feed when this material is administered. An increase in growth rate of about ⅓ pound per day is generally attained by proper administration of sex hormones.

Antibiotics may be of value in feedlot rations when cattle are first put on feed and under stress. They appear to be of value in reducing scours in calves.

Tranquilizers have been reported to increase rate and efficiency of gain but the evidence is not strong. They may be beneficial as a means of reducing stress conditions when cattle first arrive in a new environment.

Enzymes are of little value in promoting faster gains or greater feed efficiency.

Other additives will be promoted from time to time with claims of outstanding success in promoting increased rates of gain and feed efficiency. The efficacy of these products should be checked with a reliable source prior to using.

Critical Feed Periods

Starting cattle on feed or changing feed are critical periods. Any changes should be made gradually. Starter rations are used to help cattle over the stress period when changing from high roughage to finishing rations. These rations are intermediate between hay and grain in digestible energy content. They are fortified with Vitamin A, minerals, and antibiotic. A typical formulation would be 20 per cent alfalfa, 25 per cent dried molasses beet pulp, 25 per cent barley, 25 per cent oats, and five per cent Vitamin A, minerals and antibiotic. Feed hay and starter ration free choice. Add grain to the starter ration gradually. Cattle can be on a complete finishing ration within two weeks.

Grain Treatments

For efficient utilization grains should be rolled or coarsely ground. Avoid fine grinding or excessive dust. Cutting or pelleting roughage may increase consumption, rate of gain, and reduce feed wastage. Also cut or pelleted feed is better suited to mechanical feeding. These advantages must be weighed against the extra cost when deciding whether to cut or pellet. If these operations are carried out on the farm, be sure that the mill is a safe distance from stacks or buildings because there is a definite fire hazard.

Silage — This can constitute part of or the entire roughage ration for any class of beef cattle. Three pounds of silage is equivalent to one pound of hay. In severe winter weather, cattle may not eat enough to meet their energy requirements and grain feeding may be necessary.

Haylage — This feed is similar to silage but lower in moisture. Gas tight silos are required to store haylage. In making silage or haylage, the forage should be cut in the late bud or early bloom stage. Care must be taken in ensiling to avoid excessive spoilage.

Crop By-products

By-products of various crops are valuable feed. Tops of root crops, cull potatoes, cull vegetables can be fed to good advantage. Generally, these crops require supplemental grain. However, their value should not be ignored.

Feed requirements and expected gains for beef cattle[1]

	Wt.	Feed / day		Expected gain per day
		Concentrates	Roughage	
	(lb.)	(lb.)	(lb.)	(lb.)
Finishing steers	400	5.5	5.5	1.8
	600	9	7	2.1
	800	15	6	2.6
	1000	19	6	2.7
Finishing heifers	400	5.5	5.5	1.7
	600	9	7	2.0
	800	15	6	2.5
Wintering bulls[2]	400	4.5	4.5	1.1
	600	6	6	1.1
	800	7.5	7.5	1.1
	1000	9	9	1.1
Wintering calves[3]	400	4.5	4.5	1.0
	600	6	6	1.0
	800	7.5	7.5	1.0
Wintering mature cows	1100	4	10	Nil[4]

(1) The feed requirements and expected gains are average values under mild weather conditions. If cattle are exposed to stress such as cold, lack of bedding, or muddy conditions, the feed requirements will be higher.

(2) These values are for bulls selected for breeding purposes. Bulls under one year of age should be performance tested on a higher energy ration.

(3) Heifers bred as yearlings to calve as two-year-olds require extra feed. Watch the condition of the animals and feed them to gain about one pound per day.

(4) Mature cows in good condition may lose some weight in winter without harmful effects. Under severe winter conditions, additional feed may be necessary to maintain the health of the cows. Cows may be maintained on range during winter with little supplemental feeding required. However, an emergency feed supply should be kept on hand in the event of prolonged cold or deep snow.

REFERENCES

	Bulletin Number	Agdex Number
United States Sources		
Beef Cattle Breeding	U.S.D.A. Ag. Bulletin 286	Not available from Alberta Dept. Agric.
Goals and Methods in Beef Cattle Improvement	Colorado Ag. Expt. Bulletin 523-S	
Canada Department of Agriculture		
Feedlot Finishing of Cattle and Lambs in Western Canada	1236	420/20

DAIRY CATTLE

Maintaining a dairy herd as a major farm enterprise is a complicated operation that requires considerable specialized knowledge and managerial ability. A high producing herd is basic to a successful dairy enterprise. The major return from a dairy herd is from the sale of milk or butterfat. Access to a good market is, therefore, essential. The availability and opportunity for the sale of breeding and surplus stock is also important.

A dairy herd may be maintained by breeding and raising replacements, or by the purchase of dairy stock. Under most circumstances, dairymen should raise their own replacements.

Dairymen can improve the "production potential" of their cows through sound breeding programs, but this inherited potential can only be fully realized with proper feeding, care and management of the herd.

Breeding and Selection

(1) Have the herd on a recognized production testing program. Use the results as a basis for culling and selection within the herd.
(2) Keep individual records on all animals, for example, health, breeding, production.
(3) Keep heifers from cows with the highest records.
(4) Retain the high producers.
(5) Cull low producers.
(6) Use sires from high producing cows or plus-proven A.I. sires.

Feeding

Proper care and feeding are just as necessary as well-bred cows. The daily feed requirements must be met to maintain efficient and profitable milk production. Most dairymen grow their own feed and pasture. A satisfactory rule in planning rations for dairy cattle is to feed roughage according to body weight, and grain according to production. A dairy cow will consume 2½ pounds of an excellent quality dry roughage for every hundred pounds of body weight. She will consume less of a poor quality dry roughage. The rate of grain feeding depends largely on the amount of roughage consumed. (See tables 1 and 2.)

TABLE 1
Grain Feeding Guide (lb.) with EXCELLENT *Forage

Lbs. milk per day	Milk Fat 3.5%	4.0%	5.0%
20	0	0	0
25	0	0	3
30	0	1	6
35	3	4	9
40	5	6	11
45	8	9	14
50	10	11	17
55	13	15	22
60	16	18	26
65	19	22	31
70	24	26	35
75	29	31	
80	33	36	
85	37	40	
90 and above	Feed grain to maximum appetite		

*Forage calculated at 60 per cent TDN with an intake of 2½ pounds per 100 pounds of body weight.

TABLE 2
Grain Feeding Guide (lb.) with GOOD *Forage

Lbs. milk per day	Milk Fat 3.5%	4.0%	5.0%
20	3	5	7
25	6	7	10
30	8	9	12
35	11	12	15
40	13	14	18
45	16	18	22
50	19	21	26
55	23	25	30
60	27	29	34
65	31	33	
70	35	37	
75	39		
80			
85 and above	Feed grain to maximum appetite		

*Forage calculated at 50 per cent TDN with an intake of 2 pounds per 100 pounds of body weight.

REQUIREMENTS

Roughage

Three tons of good quality roughage plus grazing during the pasture season are required. If silage is fed during any part of the season, three pounds of silage is equivalent to one pound of hay. The area required to produce adequate forage will depend upon the soil, climate, and type of forages used. Both hay and pasture should be of high quality for all classes of dairy cattle. Best results are obtained when liberal amounts of high quality roughage are fed.

The best hay for dairy cattle is green colored, leafy, fine-stemmed legume or mixed grass and legume hay. Legumes should be cut in the ¼-bloom stage and grasses shortly after heading out. Grass or legume silage made from the same forage as hay can make an excellent roughage for dairy cattle. Oats are most often used for silage on dairy farms throughout central Alberta. (See "Silage", page 78.)

Pastures usually provide the cheapest source of feed. They should be managed so that there is new growth and adequate forage at all times. Avoid overgrazing or grazing too early. Rotational grazing, seeding recommended mixtures, fertilizing, the control of weeds, and the clipping of pastures are other important considerations in pasture management. (See "Pastures", page 74.)

Under certain conditions, it may be to the dairyman's advantage to feed his cattle from stored feed all year (zero grazing). This may be done by feeding hay, silage, or green chop, or by various combinations of the three.

Concentrates

The amount of concentrates and the proper mixture to use will depend on the production of the animals and the quality of forage fed. The ration should be balanced for protein. (See Tables 1 and 2 for feeding schedules and refer to University of Alberta publication "Dairy Cattle Production in Alberta".)

Dairymen with high producing cattle should feed more grain early in the lactation than is indicated on the feeding tables. Commence this high level of grain feeding gradually at least two weeks prior to calving. Grain allowances of the fresh cow should continue to increase until there is no further increase in milk production. Cows will increase production to their inherited potential in response to this added feeding. Do not overfeed cows which do not respond.

Minerals and Vitamins

Dairy cattle require minerals and vitamins for production and reproduction. Cobalt-iodized salt at one per cent of the grain ration, and a calcium-phosphorus supplement at one per cent of the ration, should be fed at all times. A mixture of a calcium-phosphorus mineral supplement and salt should be provided free-choice through the year. If dairy cattle are being fed large amounts of legumes, then a high phosphorus supplement is recommended.

TABLE 3 — Feeding Schedule For Calves

	Colostrum	Whole Milk	Skim Milk	Milk Replacer	Calf Starter	Grain Mixture
(1) Fluid Milk Producer with some surplus or Manfacturing milk producer	1st 3 days	250 lb. total 1st 4 to 6 weeks in decreasing amounts per day	———	———	4 to 6 weeks to 4 months free choice	4 months to 1 year 3 to 4 lb. per day
(2) Fluid Milk Producer with little surplus	1st 3 days	150 lb. total 1st 3 to 4 weeks in decreasing amounts per day	———	———	3 to 4 weeks to 4 months free choice	Same
(3) or	1st 3 days	———	———	As directed by Manufacturers 1st 4 to 6 weeks	Same as (1) 4 to 6 weeks to 4 months free choice	Same
(4) Churning cream shipper with excess skim milk	1st 3 days	———	10 to 12 lb. per day to 4 mo.	———	———	From 6 weeks to 4 mo. full feed. 4 mo. to 1 year 3 to 4 lb. per day

NOTE:— (a) Calf starter should be given during the last 10 to 14 days that calves are receiving milk or milk replacer. Calves may be weaned when they are readily consuming the starter.

(b) Calves should receive excellent hay or good, parasite-free pasture.

Cattle on pasture should not require vitamin supplements. But during the winter, vitamin A should be provided at the rate of 20,000 I.U. per head per day. This is in addition to that found in good quality hay. (See page 138 regarding a deficiency of Vitamin A.)

Water

Water is essential to life, and animals should have free access to it at all times. Cows on dry feed require up to one-half gallon of water for each pound of milk produced.

Bedding

The bedding requirements vary depending upon the type of housing. In a stanchion barn, the requirements are approximately 1,800 pounds per cow per year; in a loose housing barn 3,100 pounds per cow per year.

Care and Feeding of Young Stock

The care and feeding of young stock is an important part of the dairy enterprise. Most heifer calves are needed for herd replacements and, therefore, careful planning of the raising of the calves is important. The first milk or colostrum is necessary for the health and thriftiness of newborn calves. The calves should nurse their dams or receive their dam's milk for at least three days.

Feed Requirements for Young Stock

Calves to one year — Milk — 250 pounds, grain 1,000 pounds, hay — 2,000 pounds, plus some pasture.

Yearlings — Hay free choice — 3,000 pounds, plus pasture in summer. Grain — 300 pounds.

Yearling cattle need good quality hay or pasture for proper growth. During the last six weeks before calving, they should receive a grain allowance. (See Table 3.)

MANAGEMENT

Age to Breed

Because of variations in feeding and management, it is recommended that the weight of the animal be considered as well as the age. Most dairy animals should calve by the time they are 24 to 25 months of age. (See Table for breeding.)

TABLE

Breed	Weight	Age in months
Holstein and Brown Swiss	750 - 800	15 - 18
Ayrshire	625 - 675	14 - 17
Guernsey	575 - 625	14 - 16
Jersey	525 - 575	14 - 16

Housing — Two systems of dairy cattle housing are in common use.

(1) Stall or stanchion.

(2) Loose-housing or free-stall housing.

In most cases, stall housing requires more labor but working conditions are more ideal. Free-stall housing is being used as it requires less bedding than normal loose-housing and can be easily adapted to mechanical feeding and parlor milking. Dairying requires a large investment in buildings and equipment. Careful management and planning are, therefore, very important. Dairymen should have a master plan for any changes to be made in their buildings.
See reference two.

Dairy Herd — Even though the animals are properly housed and fed, the dairy herd should be watched carefully for any sick animals or diseases of any kind. Mastitis takes a heavier toll from the dairy industry than any other disease.

Mastitis organisms gain entrance to the udder through the teat canal. Proper management is important in the control of mastitis.

(1) Follow your milking machine manufacturer's instructions.
(2) Prevent udder injury.
(3) Use straw liberally.
(4) Keep cows from lying on cold wet ground or other surface.
(5) Make sure replacement cows are free from mastitis.
(6) Do not allow young calves to suck each other.
(7) Handle dry cows carefully.
(8) Practise proper sanitation during milking.

(See "Mastitis", page 178.) Please refer to references for further information.

Dry Cow and Calving

Cows require a dry period of at least six weeks to restore body reserves for the next lactation. During the dry period, the cows should be fed so as to ensure a strong, thrifty condition at calving. Cows may be treated for mastitis during the dry period. Following calving, do not breed back for 60 days.

Special care at calving includes:

(1) Isolation in clean, well-bedded pen several days before due.
(2) Give aid only when necessary. Call a veterinarian if serious difficulties are encountered.
(3) Be sure the fetal covering is removed from the calf's nostrils, and allow the cow to lick the calf.
(4) Disinfect the navel cord with iodine.
(5) Offer lukewarm water to the cow.
(6) Be **positive** the cow has dropped the afterbirth.
(7) Adjust grain feeding to level of production. (See Tables 1 and 2, page 140.)

Herd Sire

The herd sire should be kept in separate quarters that provide shelter and an exercise yard. The herd sire should be fed good quality hay and enough grain to maintain him in a thrifty condition.

Beef from the Dairy Herd

As the demand for beef continues to increase, and the cost of feeder cattle increases accordingly, many cattle feeders may use male dairy animals as feeders. These animals are mainly from the larger dairy breeds either as purebreds or by using beef type bulls on dairy cows. The dairyman who expects to stay in business should not crossbreed his animals to beef bulls because he will have a difficult time in rearing sufficient replacements.

There are two main systems in feeding dairy males for beef. One is an intensive system where the animals are fed a high concentrate ration at all times and are usually ready for market at approximately a year of age. Under the second plan, the calves are fed a high roughage ration and pasture and are fattened during a short feeding period. They then are slaughtered at approximately 18 to 24 months of age.

The system used will depend upon the feed and labor available.

The success of either system depends upon the skill of the operator in raising his calves. Whether the dairyman is feeding his own calves, or selling them to a farmer who is specializing in feeding male calves, there are certain rules to follow. Raise or buy only healthy calves that have received their dam's colostrum. Handle the male calves similar to replacement heifers during the first two months. Then full feed them either a high energy ration with a limited amount of roughage, if they are to be marketed at an early age, or feed them limited amounts of grain and high quality roughage or pasture if they are to be marketed at an older age.

When males of the larger dairy breeds are fed on the high-energy system, the following results should be obtained:

(1) Daily gains from birth to slaughter of 2.5 to 2.8 pounds.
(2) Total feed consumed from 4,300 to 5,500 pounds on a ration with a concentrate-to-hay ratio of 4 : 1.
(3) Carcasses will grade Good or Standard.
(4) Dressing percentages will be 56 to 60 per cent.
(5) Hormone implants produce favorable responses.

Feeding male calves for beef production offers the dairyman a means to increase his enterprise without increasing total milk production. However, the dairyman should not neglect his main herd in adding a feedlot enterprise to his unit.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Mastitis Prevention and Control	26	667-1
Dairy Cattle Housing and Equipment	—	713/410
University of Alberta		
Dairy Cattle Production in Alberta		
Canada Department of Agriculture		
Mastitis Must Be Beaten	1082	663

SWINE

ECONOMIC RETURNS

Swine make a significant contribution to Alberta farm economy. With average annual production during the past five years of over 1,800,000 pigs, valued at over $70 million, Alberta ranks second to Ontario in pig production. In addition, the hog industry supports a large secondary processing, wholesale and retail business.

Pigs are produced in Alberta on approximately 40,000 farms. Fifty per cent of our pigs come from farms marketing less than 62 pigs per year. This size of unit is frequently too small to make effective use of advanced extension information. However, production is rapidly becoming more specialized. To realize maximum returns from a commercial hog operation, it is necessary to be efficient in breeding, feeding, management and marketing.

Carcass quality is of particular importance as the consumer demands a lean product. This requirement is not being met by the majority of Alberta pigs, although the grades have improved during recent years, reaching 38.5 per cent grade A in 1965. This compares with a Canadian average of 39.8 per cent grade A for the same year. The average price differential of $6.50 between a grade A and C hog can easily represent the difference between profit and loss. Fat hogs are not cheaper to produce than lean hogs; in fact it costs more to produce fat than lean because fat has a much higher energy content.

At present, detailed experiments are in progress in an attempt to devise a grading system that reflects more accurately the true cut-out value of a carcass. The Swine Record of Performance carcass evaluation was changed in 1965 to a new system which allows a better prediction of lean to fat ratio in the carcass than was possible in the former R.O.P. carcass score.

BREEDS AND BREEDING

Certain breeds are inherently more suitable for the production of high quality carcasses than others, but there are good and bad individuals within all breeds. Breeding stock should be selected with due consideration to performance records.

Bacon breeds available in Alberta are the Yorkshire, Lacombe, Landrace and Tamworth. The former three breeds are white in color and have, on the average, desirable carcass characteristics. They probably are the best breeds to use either in a purebred operaton or in a grade or crossbreeding program. The colored breed provides greater resistance to sun-scald, an important consideration

when pastures are used. With an increase in confinement-rearing of pigs, this consideration is becoming of less importance. On the average the Tamworth does not yield as desirable a carcass as the other breeds mentioned. Carcasses showing pigmentation cannot grade higher than B.

New breeds and lines of meat type hogs have been developed in the United States and Europe but these cannot be generally recommended until they have been adequately tested in Canada. Meat strains of two U.S. breeds, the Hampshire and Poland China have been extensively tested in Alberta in recent years. It is evident that from these breeds, particularly the Hampshire, boars can be selected which will sire progeny equal or superior in cut-out value to the provincial average.

The best breeding systems for commercial production differ from those best adapted to seed stock production. It has been established that the mating of unrelated animals results in more vigor and thrift than the mating of related animals. A commercial producer should take advantage of hybrid vigor in his breeding program using boars selected on performance rating. Out-breeding and cross-breeding are the systems which produce hybrid vigor.

FEEDING

The principles of nutrition outlined on page 129 apply to pigs. For details on feeding and management see reference on page 149.

Pigs fed balanced rations require 600 to 750 pounds feed from weaning to market. If fed as recommended, a sow requires about 2,500 pounds of feed per year which must be charged against her pigs. This figure emphasizes the importance of marketing large litters and getting two litters per year from a sow. All producers should aim at a minimum of 15 pigs marketed annually for each sow on inventory.

Grains form the basis of hog feeding in Alberta. Table one outlines suggested mixtures of grain and a complete protein-mineral-vitamin supplement or "35 to 40 per cent commercial hog concentrate" which is usually the feasible method of balancing rations.

METHODS OF FEEDING

Self-feeding of market hogs is generally recommended because of low labor requirements. Restricted feeding of finishing pigs will reduce the rate of gain but may improve feed efficiency and carcass grades. Recent experiments suggest that, on the average, economic returns will not be increased by feed restriction of gilts but may be improved by restriction of barrows which normally eat more and get fatter when full-fed.

Self-feeding may produce grading results comparable to restricted feeding if the ration is diluted with fibrous feeds such as oats or alfalfa meal. But efficiency of feed utilization will not be as good as when a higher energy ration is fed. Therefore, feeding diluted rations can seldom be justified economically. Sows should normally be hand-fed so that consumption can be controlled. Individual feeding of sows is recommended. A very bulky ration such as one containing 25 to 30 per cent ground alfalfa is required if sows are self-fed. Otherwise, the sows will become too fat for best performance.

SUPPLEMENTAL FEEDS

Protein

In a protein supplement for pigs the quality of protein is as important as the quantity. Proteins are built up of over 20 amino acids, 10 of which are essential for the pig. It is the presence of the proper proportion of these essential amino acids that makes some protein supplements more valuable than others.

In our cereal grains lysine is the first limiting amino acid. Commercial supplements are compounded from a blend of vegetable meals such as soybean meal, rapeseed meal and linseed meal, animal by-products such as meat meal and fish by-product supplements. Individual producers with adequate feed mixing facilities may formulate their own concentrates. However, they should recognize

TABLE 1 — Suggested Rations for Swine

Type of Ration		Prestarter	May be combined: Starter	May be combined: Grower	Finisher	Sows[3]: Pregnancy	Sows[3]: Lactation
Weight of pigs	lb.	10 - 40	40 - 75	75 - 110	110 - 200		
Expected daily gain	lb.	0.8	1.4	1.6	1.6 - 1.8	0.7 gilts 0.5 sows	
Recommended digestible energy	kcal./lb.	1600	1540	1500	1400	1350 - 1400	1450
Recommended protein	%	22	17 - 18	15 - 16	13 - 14	15	15
Average daily feed consumption[1]	lb.	1.6 weaned 0.5 if used in creep	3.5	5.0	6.5[4]	5.0[5]	12 - 16
Barley and/or wheat	%	Complete	80 - 85	50 - 85	42 - 72	20 - 40	30 - 65
Oats	%	Commercial	- 2	0 - 25	0 - 40	40 - 50	20 - 50
Alfalfa meal or hay	%	Mixed ration	0	0 - 10	0 - 10	10 - 30	—
35% to 40% concentrate	%	Recommended	15 - 20	12 - 15	8 - 10	12 - 15	12 - 15

(1) On good pasture, feed intake of pregnant sows should be restricted to one-half this level.
(2) Oat groats may be fed in the starting period.
(3) Boars should be fed similarly to pregnant sows with an increase in feed when breeding.
(4) Limit-feeding at 5 to 6 pounds per day may improve carcass quality, particularly of barrows.
(5) Higher feed intake may be needed in winter when sows are in colony houses.

that such protein-mineral-vitamin supplements are complex. An individual producer is seldom in the position to make adequate substitutions and buy in bulk so as to take advantage of lower prices. Simple combined protein and mineral supplements which have proven reliable may be made up as follows:

Feeds	Growing Pigs	Sows
Soybean meal[1]	64.75	50
Meat meal or other animal protein	25	25
Alfalfa meal or ground hay	—	15
Ground limestone	5	5
Iodized salt	5	5
Zinc sulphate	0.25	—
Antibiotic supplement	—[2]	—
Vitamin A and D supplements	—[3]	—[3]
	100 lbs.	100 lbs.

(1) Not over ½ may be replaced by rapeseed meal, linseed meal, or similar vegetation proteins.

(2) To supply the equivalent of five grams of antibiotic per 100 pounds of supplement.

(3) To supply the equivalent of 400,000 I.U. of vitamin A and 70,000 I.U. of vitamin D per 100 pounds supplement for growing pigs and 2½ times these levels for sows. In addition, a B-complex vitamin mix is desirable.

Skim milk or buttermilk, if fed as recommended in Table 2, will replace other protein supplements, but will not supply all the necessary minerals and vitamins. A free choice mixture of iodized salt and ground limestone and recommended levels of vitamins and A and D must still be fed.

TABLE 2 — Skim Milk and Undiluted Buttermilk for Pigs

Weight of pigs	Lb. Skim milk or Buttermilk per lb. of grain
Weaning to 75 lb.	2.5
75 to 110 lb.	2.0
110 lb. to market weight	1.0
Sows	1.5 - 2.0

MINERALS AND VITAMINS

Commercial protein-mineral-vitamin supplements are adequately fortified with minerals, vitamins and antibiotics. However, for home prepared rations bear in mind the following requirements of pigs.

Pigs require 0.5 pounds iodized salt and approximately 0.5 pounds ground limestone per 100 pounds total ration or free-choice access to a mixture of these minerals. In addition, pigs require 50 to 100 parts per million of zinc in the ration to prevent the possible development of parakeratosis, a disease of the skin accompanied by severe scurfiness and unthriftiness.

This disease usually occurs shortly after weaning. Zinc oxide, zinc sulphate or zinc carbonate at levels of ⅓ pound, ¾ pound and ½ pound respectively per ton of complete ration will combat this condition. Excess calcium in the ration aggravates parakeratosis. This observation demonstrates the inadvisability of adding excess minerals to a ration.

Vitamin A (1,000,000 I.U. for market pigs and 2,500,000 I.U. for breeding stock per ton of ration) and vitamin D (200,000 I.U. per ton of ration) are recommended. Vitamin A may be added to the ration at double the recommended level. This is because vitamin A may be unstable in mixed feeds and some stress conditions seem to increase the need of this vitamin.

Carotene in hay and pasture is a precursor of vitamin A but should not be relied on as a source of the vitamin in typical pig feeding practice in Alberta. It is advisable that riboflavin, niacin, calcium pantothenate and vitamin B_{12} be included in rations of young growing pigs to meet conditions of stress that may occur. Ten to 20 grams of antibiotic per ton of feed for growing hogs and 25 to 50 grams per ton in creep feed and starter rations are advised. High level feeding of antibiotics may be desirable under certain conditions but should be checked with your veterinarian, feed manufacturer or district agriculturist.

PASTURE

Pasture is useful for sows and prospective herd gilts and boars but not for growing pigs if balanced rations are fed. Pasture may reduce labor requirements, provide more sanitary conditions and allow market pigs fed straight grain to balance their rations but it will decrease rate of gain and usually decrease feed efficiency as compared to indoor rearing. Based on several years studies at the University of Alberta, market pigs on pasture with colony houses for shelter took two weeks longer to get to market, required 40 pounds more feed per pig but graded higher than those fed inside. An acre of good pasture will carry 10 sows, or three to five sows with litters. Annual cereal pastures are recommended for reasons of sanitation. The choice of pasture type is secondary to providing green forage for the entire growing season. Sows may be satisfactorily raised without access to pasture if they are provided with completely balanced rations.

WATER

A pig requires about 2½ pounds of liquid for each pound of solid feed. In warm weather they may drink up to four pounds of water per pound of feed. Water should be available to pigs at all times, preferably by automatic waterers. It must be kept ice-free in winter. An unlimited supply of water must always be available for lactating sows. Young pigs receiving creep feed or those that are newly weaned will not eat unless water is available. Water high in mineral content may be undesirable for pigs and questionable water should be analyzed. If water intake is reduced particularly in warm weather, the health and growth of the pigs will suffer. Prolonged withholding of water prior to shipping market pigs will cause excessive carcass weight shrink.

MANAGEMENT

Sows should be fed four to six pounds per day or two to three pounds per day if on pasture. Feed may be increased to six to eight pounds about one month prior to farrowing. Individual feeding of sows should be practised if possible. Although flushing is frequently recommended, it will not be feasible if sows are rebred immediately after weaning. Sows will normally show estrus four to six days after their litters are weaned and for maximum efficiency should be rebred at this time. Experimental results indicate that rebreeding in this first heat period does not have a deleterious effect on litter size and other performance characteristics.

Care at farrowing time is extremely important as this is when the heaviest pig losses occur.

Gestation period — This is 112 to 115 days; or three months, three weeks and three days. Move sow into farrowing quarters one week before farrowing date.

Farrowing Points

(a) **Warm farrowing quarters** — artificial heat is required. The sow is most comfortable at 60 to 70 degrees F. while the young pigs should be kept at 85 to 95 degrees F. during early life. Therefore, extra heat is required in the creep area.

(b) **Clean and disinfect pen or stall.** Use one pound lye to 30 pounds hot water or recommended disinfectants.

(c) **Wash Sow** — If weather permits, thoroughly wash udder and preferably the entire sow with warm water and soap.

(d) **Guard Rail** — A guard rail eight inches from floor and eight inches from wall, or use farrowing stalls. The type of farrowing stall or pen is probably not as important as the necessity of individual attention.

(e) **Little Bedding** — Avoid coarse straw and use a minimum amount of bedding.

(f) **Attend Farrowing** — Be present when sow is farrowing.

(g) **Take-out "Black Teeth"** — Remove "black teeth" with sharp nippers. Do not injure gums.

(h) **Iodine Lacking** — Birth of hairless pigs indicates iodine deficiency.

(i) **Weak Litters** — Birth of weak litters usually indicates lack of protein, minerals or vitamins in sow ration.

(j) **Milk Failure** — Failure of sow to milk may be caused by :

1) Ration imbalance during pregnancy, frequently a lack of protein and/or pasture.
2) Too concentrated a ration prior to farrowing. Use bulky feeds such as bran and oats.
3) Lack of exercise. Although sows may be reared in confinement some sows appear to require reasonable exercise.
4) Inadequate water supply. Give sow all the warm water she will drink.
5) Bringing sow on feed too rapidly.
6) A fever lasting more than a few hours will stop milk flow. Treatment with 1.5 to three million units of penicillin may be helpful.
7) Milk let-down can sometimes be initiated by use of a hormone injection. Contact your veterinarian.

SOW AND LITTER

(a) **Anemia** — Prevent anemia in suckling pigs. Give an iron compound by mouth at twice weekly intervals from three days to three weeks of age or inject an iron dextran or similar iron complexed compound at three to five days of age.

(b) **Creep Feed** — Supply creep feed beginning at one week of age. Commercial pre-weaning rations are recommended as such rations are complex. Water must be readily available to the young pigs.

(c) **Orphan Pigs** — Orphan pigs or extra pigs from large litters may be raised if they are able to get first milk or colostrum from the dam and if a program of extreme sanitation is followed. Commercial milk replacers are most desirable but the following formula has proven useful.

Cow's milk	1 quart
Water	1 pint
Sugar or honey	1 teaspoon
Antibiotic supplement approx.	0.25 gram of antibiotic, preferably a soluble supplement.

Such a formula must be fed at least six times daily for the first few days and must be kept fresh. Warm to body temperature before use. Place dry pre-weaning ration in the pen at one week of age. Orphan pigs are very subject to ailments. Unless a producer is willing to spend considerable time, it frequently does not pay to raise them. Pigs can frequently be transferred to another sow if there is less than 24 hours difference in age.

(d) **Early Weaning.** Under practical conditions five to six weeks weaning is quite feasible and will give as good results as eight week weaning. Weaning at three weeks of age or 10 pounds in weight should be practised only by the specialized producer who can supply superior management. Unless a producer makes use of early weaning to get more litters from his sow it offers no advantage over later weaning.

(e) **Castration** — Male pigs intended for slaughter should be castrated prior to six weeks of age. As it is recognized that boar carcasses are much leaner than barrow carcasses, further research is needed to find satisfactory methods of producing meat from young boars. Boars cannot be marketed under present market standards.

FOLLOWING WEANING

Once a pig reaches 50 pounds in weight it is past the most critical stage of its life. But proper feeding and management cannot be ignored. Pigs of this age are still subject to diseases and parasites. (See Livestock Diseases section, page 174.)

(a) **Pen Area** — Allow six sq. ft. per pig to 100 pounds and nine sq. ft. per pig to market. Do not group pigs that vary widely in weight. With most operations, pens should be designed to hold 24 or less pigs. If a pig shows signs of unthriftiness or sickness, remove to a hospital pen. Crowding of pigs often contributes to tail chewing and cannibalism. Slotted floors or partially slotted floors may reduce the area required per pig.

(b) **Tail Biting** — This may be associated with numerous management and feeding practices. Overcrowding of pigs, particularly in large groups of 20 or more, may lead to tail biting. Mixing pigs varying considerably in weight may also be a predisposing factor. Frequently only one or two aggressive pigs start tail biting initially and if these cannibalistic animals are located and removed immediately, no further trouble may develop.

Lack of minerals particularly salt, calcium, and possibly iodine, lack of protein, extremely high energy and low fiber rations may increase the frequency of tail biting. Pigs on restricted feeding are more likely to tail bite, probably because of boredom when they have nothing to do.

Some producers remove the tails from their pigs shortly after birth and this practice is usually successful in preventing cannibalism. If pigs start to tail bite, remove the offending pigs and check management and feeding.

(c) **Worm Treatment** — (See also page 175. Shortly after weaning treat for intestinal roundworms. Methods:

Piperazine derivatives, cadmium oxide compounds—To be used as directed by the manufacturer. See your local feed agent, veterinarian or district agriculturist for most recent recommendations.

(d) **Market Weight** — To get maximum returns from hogs they should be marketed at 190 to 205 pounds to give carcasses within the allowable weight range of 135 to 170 pounds for a grade A carcass. As there is an increased tolerance of ¼ inch in backfat between a 150 and 151 pound carcass, best grades can usually be obtained with carcasses weighing over 140 pounds or under 151 pounds. A weigh scale is recommended for all hog producers.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Control of Livestock Insects 1966-67	—	651
Catalogue of Plans—Swine Housing and Equipment	—	713/440
University of Alberta		
Swine Production in Alberta	22	440/20
Handy Record Book for Swine	L-SW 63	Available at 25¢ per copy

SHEEP

The sheep population of Alberta is declining. Though the national yearly per capita consumption of lamb is three pounds, Canada imports one-half of the lamb consumed and uses ten times the amount of wool produced. Currently the sheep industry provides two of the few non-surplus agricultural products on the continent. With intensified management, breeding and feeding of sheep, there is no predictable limit to what may be accomplished.

MANAGEMENT

Size of operation. A minimum of 500 ewes can comprise an economic unit. If providing only a portion of farm income, at least 100 ewes should be kept.

Feeding Practices. Generally, five ewes are equivalent to one cow in feed requirements. For maximum forage yield and internal parasite control, rotate sheep on no less than three pastures per year. Mow, fertilize and harrow tame pasture immediately after use. Avoid overgrazing which tends to eliminate the superior varieties. In addition, avoid undergrazing which results in lowered nutrition and patchy grazing because sheep dislike high grass. To prevent bloat, limit legumes in pasture mixes. Graze cattle and sheep together for more production per acre because of wider use of plants. When dry-feeding, prevent feed from dropping on to the wool.

Housing — Housing need not be elaborate — a windbreak and open-front shed is adequate. Provide ten square feet of shed space and 25 square feet of corral space per ewe. To prevent disease, avoid the use of winter quarters in summer and choose a well-drained location with a southern exposure. Lambing quarters should be well-ventilated, dry and without drafts. Heat should be provided in the lamb creeps during cold weather.

Equipment. For lambing allow one four-foot by four-foot lamb-claiming pen per ten ewes and provide creep feeders for the lambs. For fencing use 26 or 30-inch page wire with two strands of barbed wire. Construct three foot by 14 foot solid board panels for temporary chutes and corrals, raised up four to six inches if sheep jump.

Use open panels for feeding hay and light stacking troughs for feeding grain. Other useful equipment is portable cutting gates and hurdles. For shearing, use a wooden floor, wool-bagging frame, and slotted wool-sorting table. Weigh scales for lambs and wool are important for increased production and profit.

Comfort of animals. Do not handle sheep by the wool or throw them about. This causes bruises and lowers grades. Do not move sheep about unnecessarily—it retards growth and lowers feed efficiency. Trim hoof overgrowth to help prevent foot-rot.

Pre-breeding care. Flush ewes for 17 days prior to breeding on good fresh pasture or grain at one-half to one pound per day. When the rams are not in use, keep them in good condition. Don't let them get overfat, and allow them to exercise. Keep rams hooves trimmed and shear them if used for breeding during the summer months.

BREEDING PRACTICES

Rub lampblack or ochre into the brisket wool of the rams, changing the color every 16 to 18 days to determine if ewes are returning. Ewe-marking indicates ram fertility and breeding progress. Remove rams for special grain feeding daily during the breeding season. If possible, turn rams out to breed only at night. Provide one mature ram per 50 to 60 ewes on good pasture, 30 to 40 ewes on arid pasture and 20 to 25 ewes per ram lamb. Sheep other than Dorsets and those with Merino blood are seasonal breeders (August through March). Plan lambing time so that lambs market at highest prices.

Gestation care. Feed quality hay or pasture, adding one-half to one pound of grain per day in the final six weeks. Shear the ewes in the region of the udder and tail (crutching) before lambing. This will prevent lambs from sucking wool and make nursing easier. Shear wool-blind ewes around the eyes.

Lambing care. When ewes are due to lamb watch them closely. When a ewe lambs during inclement weather pen her with her lamb until the lamb is dry and nursing. Provide dry bedding and fresh water to all pens. Put ewes and lambs outside as soon as possible—providing it is not storming. If a ewe will not accept her lamb, pen them and tie her to prevent injury to the lamb. A ewe will accept an orphan lamb if it is rubbed over the ewe's newly stillborn lamb, or if the lamb died later, skin it and put the hide on the orphan. Pen the orphan with the ewe until adopted.

If bottle-feeding lambs, feed two to four tablespoons of high-fat milk every four or five hours for the first two days, adding a few drops of cod liver oil and

warming the milk to body temperature before feeding. Gradually reduce the number of feedings, increase the amount of milk per feeding, and give lambs access to creep feed.

Watch for mastitis. The ewe separates from the flock and appears lame in the hindquarters due to the sensitive udder. Wean an affected ewe's lambs immediately and treat her with a 15 gram bolus of sulfa methazine twice, 12 to 24 hours apart.

Creep Feeding. Fresh cracked or rolled grain plus some bran may be fed from the first few days until one month of age. Thereafter, feed whole grain through to marketing.

Weaning may be done successfully at 60 to 70 days of age and the lamb fed to market weight. With creep feeding, fat lambs may be marketed directly off the ewe.

Treatments and operations. See the Livestock Diseases Section for remedial and preventative treatments. Dock lambs' tail within two weeks of age using a hot iron or burdizzo. Castrate lambs at the same time by knife or burdizzo. Elastators are not recommended. However, if used, apply before the lambs are five days old.

Deworm sheep with thiabendazole in the spring before pasturing, as worm infestations cause unthriftiness. Earmark ewes for age indentification and ear tag them for individual identification.

Market — Market lambs properly finished at about 100 pounds liveweight for highest grades and prices. Avoid overfinishing, and fatten lambs at an early age. To avoid shrinkage and loss of finish, arrange to have lambs slaughtered no later than the day after they are shipped. Have lambs rail-graded to know what you are producing.

Shippers should contact their marketing agent to find out which days sheep are being shipped. Shipping on this date will prevent late kills.

Wool. Shearing is done mainly by machine, some by hand, in May, usually after the danger of cold storms is past. Sheep must be dry at shearing or the wool will mold in the bags. To cause the grease to rise up into the wool and facilitate shearing, pack the sheep into a ventilated sweat shed just prior to shearing. Shear on a wooden platform to keep the wool clean and dry, and prepare the wool on a slotted four by eight-foot table. Spread the fleece weather-side upon the table, sort out the tags, black, and leg wool and pack it separately. Fold the fleece in from each side, roll it from breech to neck and tie with paper string. Never use binder twine. Tramp the fleece tightly in bags, hanging up off the floor in a frame. Dung tags, leg wool, small clippings, foreign matter including unscourable brand paint, breaks in wool due to poor nutrition, and black fibre in the wool all result in lower prices.

Miscellaenous. Sheep dogs and a lead sheep are valuable for trailing and working sheep. Border Collies have proven to be most suitable for this purpose.

Use 1080 poison, strychnine, hounds or repellent ear tags to reduce predator loss. Confine lambs if the predators cannot be controlled.

All supplies necessary to a sheep operation are obtainable through Sheep Breeders' and Wool Growers' Associations.

BREEDING

Alberta Record of Performance Home Test. Consult your district agriculturist or the Animal Industry Division for information and application forms. Record books and other materials are supplied.

Records — Records are essential for improvement. Include the following: Number of lambs born to the ewe, days to market from birth, market weight of lambs, grades, feed used, weight, density and staple length of fleece.

Breeding Selection — Select rams and replacement ewes for economic returns and soundness (includes teeth, hooves, udders, bone structure) and freedom from such defects as undershot or overshot jaw. Concentrate on as few characters as possible for rapid herd improvement. The characters most desirable are quick growth, high feed efficiency and heavy, high quality wool growth. Select superior rams because one ram influences the character of many lambs.

General recommendations. Use a meat-type ram (e.g. Suffolk, Hampshire, North Country Cheviot) and good wool ewes (e.g. Columbia, Rambouillet, Romnelet, Corriedale). Dorsets are used for their longer breeding season. For ewe flock replacements, use wool breed rams on the best brood ewes. For small flocks, replacement ewes may have to be purchased. Crossbred ewes produce more and heavier lambs, and should be mated to a ram of a third breed possessing the desired economic characteristics.

NUTRITION

Water should always be available and for maximum pasture provide water within easy reach from any part of the pasture. Feed loose cobalt iodized salt and a 50 per cent dicalcium phosphate — 50 per cent mineral mix (trace minerals included) free choice. Feed vitamin A in the winter, particularly if hay is weathered. Also feed vitamin D.

In the winter, four to five pounds of hay is required per ewe. It should be good hay containing at least some legume. Silage alone is not recommended. Green oat bundles may be used to advantage as part of the roughage fed. If hay is poor, add a protein supplement to the ration. Supply sufficient energy in the last six weeks of pregnancy to prevent pregnancy disease.

Lamb feedlots require a windbreak, and some bedding in very cold or wet weather. Start lambs on good legume hay and about one-tenth pound of whole oats per day per lamb. If hay is of poor quality, add a protein supplement to the ration. Bring lambs up to full feed, gradually feeding what they will clean up and then begin replacing whole oats with whole barley. Lambs may be self-fed.

ADVANCED PRACTICES

Three lamb crops in two years. This practice provides greater utilization of ewes and rams. It means year-round production which also stabilizes prices. It permits more efficient use of labour, buildings and equipment. The problems encountered may be scarcity of management, heavy culling of late or seasonal breeders, special technical methods utilizing hormones or control of the hours of light the ewes are subjected to daily.

Use sheep which breed year-round and space lambing at four-month intervals by dividing the flock into two bunches with alternate lambing. Wean the lambs at 60 days of age and dry the ewe for 10 days before breeding. Synchronize cycling with the use of hormones. Ewes may be bred within 36 to 72 hours after the hormone treatment.

Slatted Floors for Sheep — Slated floors are used for reduced labour and internal parasite problems. The drawbacks are the high cost and that a good manure handling method has not been devised. Four square feet of space per fattening lamb is sufficient. Slats are built two feet off the floor in four by five foot grids of 1½ inch wide slats ⅝ inches apart.

Year-round confinement rearing of the flock is another new practice being attempted to reduce predator and parasite affliction, cut out fencing costs, intensify land use and exert more direct control over the flock's nutrition.

The material on sheep contained in this guide is not comprehensive. If contemplating investing in sheep or attempting new methods, seek qualified help. Your district agriculturist or the livestock supervisor are willing to give direction.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Control of Livestock Insects	651	651
University of Alberta		
Sheep Production in Alberta	52	430/10
Canada Department of Agriculture		
Feedlot Finishing of Cattle and Sheep	1236	420/20

Other Sources

Profitable Sheep, S. B. Collins, The MacMillan Co., New York.

Note:— The federal and provincial departments of agriculture operate policies designed to assist commercial breeders to obtain good rams. Obtain details from your district agriculturist.

HORSES

Even though the use of horses has been drastically reduced in recent years, there are still farm and ranch chores for which the horse remains the most economic source of power and transportation.

In their restricted use, it is more important than ever that horses be sound. Many defects are inherited but failure to care for feet, legs and teeth also will lead to unsoundness.

FEEDING

From one to 1¼ pounds of roughage and ¾ to one pound of grain daily for each 100 pounds live weight are recommended for working horses. Reduce the grain on light work or when idle. Oats are the standard grain for horses although the addition of bran improves the ration. Grass hays are preferred but mixed can be used.

In-foal mares need daily exercise and extra minerals. Keep a mixture of equal parts salt, limestone and bonemeal available to them at all times and starting in the fall, give a half-teaspoonful of potassium iodide in the feed or water every ten days up to foaling.

THE ORPHAN FOAL

Milk from a fresh cow, low in butterfat, should be used. Make up a mixture of a pint of such milk with a tablespoonful of sugar (dissolved in water) and from three to five tablespoonfuls of lime water. Warm to body temperature and feed about a fourth of a pint every hour from a bottle with a nipple. Reduce the number of feedings in a few days and teach the foal to drink as soon as possible. Lime water can be made by dissolving unslaked lime in water, allowing to stand for several hours and pouring of and using the clear liquid.

LIGHT HORSES

Both rural and urban residents have shown an increased interest in light horses. The number of light horse societies, saddle and pony and trail riders clubs, and 4-H horse clubs, have all increased in recent years. Unfortunately, it is impossible here to even attempt to give information on the many questions these societies are asking.

Fortunately there is an excellent bulletin published by the United States Department of Agriculture, entitled "Light Horses" and procurable at a very nominal price from the Superintendent of Documents, Washington, D.C.

This bulletin contains information on the breeds of light horses and their characteristics; how to select a horse; common defects; the different gaits; how to determine the age of a horse (with diagrams); care and management of breeding horses and foals; the feeding and management of light horses in general; and other useful information.

REFERENCES

	Bulletin No.	Agdex No.
Ontario Department of Agriculture		
Horses — available at 50 cents	506	
U.S. Department of Agriculture, Washington, D.C.		
Light Horses	Farmers' Bulletin 2127	

PROBLEM FEEDS

Sickness, unthriftiness, and death losses among livestock may be caused by harmful properties of the feed or drinking water. However, such feeds are often valuable for livestock when their limitations are recognized. In general thin animals can tolerate less toxic feeds than well fed animals. Always avoid sudden changes in feed, even from one source of hay or grain to another. When sickness, unthriftiness, or death losses do occur a veterinarian should be consulted. The following includes the most commonly occurring problems in Alberta.

Newly Harvested Hay and Grain

It is a common belief among some feeders that newly harvested hay and grain should go through an aging or "sweat" period in order to remove toxic

properties. This does not seem to be true, but over-eating by the animal is a distinct possibility. Newly harvested grain generally contains more moisture than old grain, and so is softer to chew and more palatable. Consequently, care must be taken to avoid over-eating.

Smutty, Rusted, Sprouted, and Frozen Grains

These are of lower bushel weights than undamaged grain. Weight of grain required per pound of gain will increase about two per cent for each decrease in one pound per bushel. These grains are not toxic to livestock with the exception of flax (see Prussic acid) and are usually as palatable as undamaged grain.

Moldy Feeds

Moldy feeds are less palatable than normal grain but are not usually harmful to livestock. Conditions that are favorable for mold growth may also encourage the production of rancid fats. The rancid fats reduce digestibility and palatability, destroy vitamins, and seem to exert a direct toxic effect. (Laboratory tests for toxicity are not available.)

Moldy hay is unpalatable. Cattle on a predominantly moldy hay ration may suffer or die from energy starvation. The lower intake of moldy hay should be compensated for by feeding more grain. If sweet clover hay or silage is allowed to spoil a compound is formed that prevents blood clotting. Sometimes the amount of mold is so small that it is not visible.

Moldy silage up to about two per cent of the total can be fed without any ill-effects, but when amounts are larger the moldy part should be discarded as a safety measure.

Fire-damaged Grain

Grain damaged by fire has been successfully fed to pigs and poultry. The more the grain is charred the lower its feed value. Wood, nails, and glass should be removed from the grain before feeding or grinding.

Ergot

Any grain that contains more than one ergot body per 1,000 kernels should be considered dangerous. Ergot infested feed may cause abortions, and its continued use produces a dry gangrene of the ears, tail, and feet. The amount of ergot can be reduced to safe levels by putting the infested grain through a fanning mill or mixing it with grain that is free from ergot. Ergot infested pastures should be cut and destroyed.

Prussic Acid

Four plants found in Alberta, arrowgrass, chokecherry, flax, and sorghum, may contain toxic quantities of prussic acid. Amounts in excess of 0.02 per cent of the dry weight are dangerous. To obtain analysis see page 231. (Feed and soil testing service.)

Selenium

Although selenium is an essential mineral for animals, a concentration of only five parts per million (ppm) is considered toxic. Soils high in selenium are found in southern Alberta near the Cypress Hills. In this area milk vetches absorb toxic quantities of selenium while most other forages do not. The toxicity of any hay or pasture is proportionate to the number of milk vetch plants present.

A selenium deficiency results in white-muscle disease while an excess produces emaciation, encrusted muzzle, abnormal hoof growth, and sores at the hoof head.

Oxalic Acid

Halogeton, a plant that looks a little like Russian thistle, has been found in southern Alberta. It contains about 10.5 per cent oxalic acid. This acid combines with calcium in the ration to make the calcium unavailable to the animal. Death may ensue. The addition of dicalcium phosphate to such a ration helps to prevent a calcium deficiency.

Nitrates

Roots take up nitrate from the soil and this is changed to protein in the leaves. If many of the leaves are destroyed by frost or drought while the roots continue to take up nitrate, an excess of this chemical will be found in the

remaining leaves. The nitrate in the leaves will also be increased after a heavy application of nitrogen fertilizer or if the change to protein is slowed down by insufficient light.

Although a level of 0.5 per cent is dangerous, reaction to nitrates varies greatly. Animals may build up a tolerance to it. Generally, nitrate poisoning occurs when animals are suddenly switched to a very palatable feed that is high in nitrates and are allowed free access to it. For nitrates in water, see section on water. To obtain analysis see page 231 (Feed and soil testing service).

Nitrogen Gases in Silage

During the ensiling process, poisonous nitrogen gases are formed. Sealing the silo with plastic sheeting concentrates the gases more than when hay or straw is used as a sealant. Care should be taken when entering a newly-opened silo and silage should be thoroughly aired before feeding. Coughing of the cattle when silage is fed is an indication that toxic gases are present in excess amounts.

Water and Algae

Good drinking water should contain less than 1,000 parts per million of dissolved solids. The nitrate content should not exceed 500 p.p.m. Blue-green algae are poisonous to livestock and the water in the vicinity of the plants is also toxic. One p.p.m. of copper sulphate in the water will destroy algae but is not harmful to livestock. The proper proportion is one ounce of copper sulphate to 1,000 cubic feet of water.

Pesticide Residues

Never feed livestock leftover treated seed grain or feeds containing pesticide residues. The allowable tolerance for most pesticide residues in meat and milk is zero. The responsibility for any residues found on these products rests entirely with the producer. For analysis see your District Agriculturist.

Grease, Oil, and Paint

These materials are poisonous and should be kept away from all livestock.

Poisonous Plants

If forage is sparse or animals are deficient in minerals they will eat plants, some poisonous, that they would not ordinarily consume. See references for a complete coverage of this subject.

DAIRYING

Dairy production in Alberta is concentrated in the black and grey wooded soil zones of the province. The number of milk cows and farms producing milk have decreased in recent years. However, the number of milk cows per farm have increased and there has been a substantial increase in the milk production per cow.

Farms producing milk for the fluid market have become highly specialized with the introduction of farm bulk tanks, milking parlors, pipeline milking and loose housing. Fluid milk receives the top price and producers of such milk must meet strict regulations of the local health units and maintain a constant supply throughout the year which is controlled by means of a quota system.

More than half the total milk produced comes from farms with six to 10 milk cows. It is separated on farms and marketed as churning cream for the manufacture of creamery butter. The skim milk is a valuable feed for hogs, calves and poultry. The combined value of the cream and skim milk, on the basis of 100 pounds of milk, is only about half that of milk utilized for fluid sales.

Well-developed dairy areas, particularly in central Alberta, are producing whole milk for manufacturing purposes. This milk is picked up daily for delivery to concentrating plants and cheese factories. Prices paid for this milk are approximately 70 per cent of that paid by fluid markets.

LEGISLATION AFFECTING DAIRY PRODUCERS

The production, processing and sale of milk and its products is governed by legislation at the federal, provincial and municipal level. Departments of Agriculture and Public Health administer regulations at all levels. In addition, most provinces have milk control boards to establish prices for fluid products. The provincial legislation in Alberta which affects dairy producers is found under three separate acts summarized in the following paragraphs:

ACTS SUMMARY

1. The Dairymen's Act and Regulations

Administered by the Dairy Branch, Department of Agriculture. Provision is made for the licensing of all dairy manufacturing and processing plants. Licensed plants must supply a bond to protect producers against financial loss. Provision is made to license qualified graders and testers of milk and cream and those engaged in this work must be licensed. Regulations under the act set forth grade standards for cream and manufacturing milk. The basis for payments to producers must be outlined by the licensed plant which must furnish to the producers a statement covering all purchases of milk and cream. Provision is made for minimum standards covering such items as construction, operation, sanitation and equipment.

The legislation prohibits the sale of milk which contains preservatives, adulterants or that which has been skimmed or diluted. Producers of fluid milk must provide a milk house with the necessary sanitary facilities. Regulations require that farm bulk tanks conform to 3-A Standards and be installed in a milk house with proper facilities for washing and sanitizing.

2. Regulations of the Provincial Board of Health (Made under authority of The Public Health Act and Administered by Local Health Units)

These regulations require that all producers of milk for human consumption obtain a certificate of registration from the local Board of Health. Provision is also made to check the health of employees on the producers' premises. Cows must be free from tuberculosis. Certain facilities for the production of high quality milk must be provided.

3. The Milk Control Act

This act empowers the Public Utilities Board to inquire into any matter relating to the production, supply, distribution and sale of milk. The board can prescribe areas which shall be regulated by orders. Approved schedules of minimum prices are established by the board having regard for the interests of the public and continuity of supply. Controlled areas presently include: Bowden, Calgary, Camrose, Crows' Nest Pass, Edmonton, Lethbridge, Medicine Hat, Ponoka and Red Deer.

RULES FOR BETTER MILKING

1. **Prepare the Cow**
   —Avoid excitement.
   —Wipe and massage udder and teats with a clean cloth wrung out of a warm disinfectant solution.
   —Use separate cloths for each cow and wipe udder dry after washing.
   —Use a screening test regularly for the detection of abnormal milk.
2. **Milk Fast**
   —Put on teat cups half minute after washing the udder.
   —Strip by machine — when milk flow slows down, pull on the teat cups with one hand and massage the udder with the other hand. (It is important that the teat cups be removed immediately milk stops flowing.)
   —Dip teat cups in clean water and then a disinfecting solution.
3. **Operate the Milking Machine according to the Manufacturer's Directions**
   —Check pulsation rate and level of vacuum regularly. A high vacuum irritates the udder tissue.
   —Clean vacuum lines at least every other month, and whenever milk is known to have entered the line.
4. **Hand milking requires —**
   —Clean clothes.
   —Clean, dry hands.
   —Quick milking.
5. **Practise Good Herdsmanship and Managed Milking**
   —Maintain cows in good working flesh and condition.
   —Keep cows comfortable using ample bedding.
   —Remove trash and obstructions from well-drained cow corrals.
   —Maintain constant vigilance over herd for signs of illness or abnormalities.
   —In winter, guard against frozen teats and udders. At all times avoid teat injury.

PRODUCTION OF QUALITY MILK AND CREAM ON THE FARM

I. **Basic Requirements**
   —A clean, healthy herd housed in a clean, well-ventilated building with clean adjoining areas.
   —Strict cleanliness of personnel at milking time.
   —An adequate, safe water supply for the stock, for cooling and for wash-up operations.

II. **Essential Equipment**
   —A milk house of suitable design and size; stainless steel or adequately tinned utensils: two-compartment sink.
   —A single-service filter strainer; detergents and cleaners compatable with the water supply.
   —Chemical sterilizers (e.g. chlorine or tamed iodine solution) for "rinse before use" purposes; (lye solution, see Special Milking Machine Treatment).
   —Stiff nylon dairy brushes — do not use cloths or steel wool.
   —A non-corrodible rack for draining and storing dairy utensils.

III. **General Procedure for Cleaning and Sanitizing Utensils :**
   1. Rinse with lukewarm water immediately after use to remove milk residue from utensils. This will aid in the prevention of milk stone formation.
   2. Wash and scrub utensils with a stiff dairy brush using hot water and a detergent to completely remove milk residue. Clean milk tubes with proper cleaning rod and burr.
   3. Rinse with clean hot water to remove all traces of detergent. An alternative after brush-washing is to place all equipment in the second compartment of wash tank containing five gallons of cold water to which organic acid detergent has been added according to instructions. The "acidified" rinse prevents "water-spotting", and the build-up of milk stone.
   4. Drain all utensils by placing on a drain rack.

5. Before use, assemble equipment and sanitize with chemical solution, such as chlorine or tamed iodine, and drain thoroughly. This sanitizes surfaces which come in contact with the milk or cream.

SPECIAL TREATMENT FOR MILKING MACHINE CLUSTERS

Milking machine clusters are the most difficult of the farm dairy equipment to keep clean, and in addition to the foregoing, the following are recommended :

1. **Wet Storage**
   With a short tube milker, the milking tubes and inflations are stored in a freshly prepared ½ per cent lye solution in a crock between milkings. With a long tube milker, the clusters are placed on a rack and filled with the ½ per cent lye solution.

2. **Defatting**
   Two sets of liners are required. One set is rested and defatted for two weeks in a five per cent lye solution, while the other set is in use and cleaned as above.

3. **Immersion Cleaning**
   This is an alternative procedure to wet storage. The assembled clusters and lids without the pulsators of both long and short tube milkers are merely rinsed and kept between milkings in a lye solution mixed with the wetting agent. (See free advisory leaflet No. 159 for complete details.)

IV. Cooling

Immediate, fast cooling of milk and cream to at least 50° F. and preferably 40° F. is essential. Use a good thermometer. Low temperatures should be maintained during storage period up to shipping time. Prevent freezing.

During shipping, protect milk or cream from extremes of temperature. Effective means of cooling are :

(a) Circulating cold water in a tank of sufficient capacity; and

(b) Mechanical refrigeration.

Air cooling is not satisfactory for fast cooling. Experiments have shown that water cools 21 times faster than air at the same temperature.

Precaution — Do not mix fresh warm milk or cream with the previously chilled supply. Always cool first—then mix if necessary (unless using bulk tank). The household refrigerator is not recommended as a storage unit for separated cream because it is susceptible to strong food odors unless kept in an enclosed container.

BULK COOLING TANKS

Bulk tanks are of two types :

(a) those which are filled by gravity and are at atmospheric pressure, and

(b) vacuum tanks in which the vacuum is maintained by the vacuum pump of the milking machine.

This is usually combined with a pipeline milker.

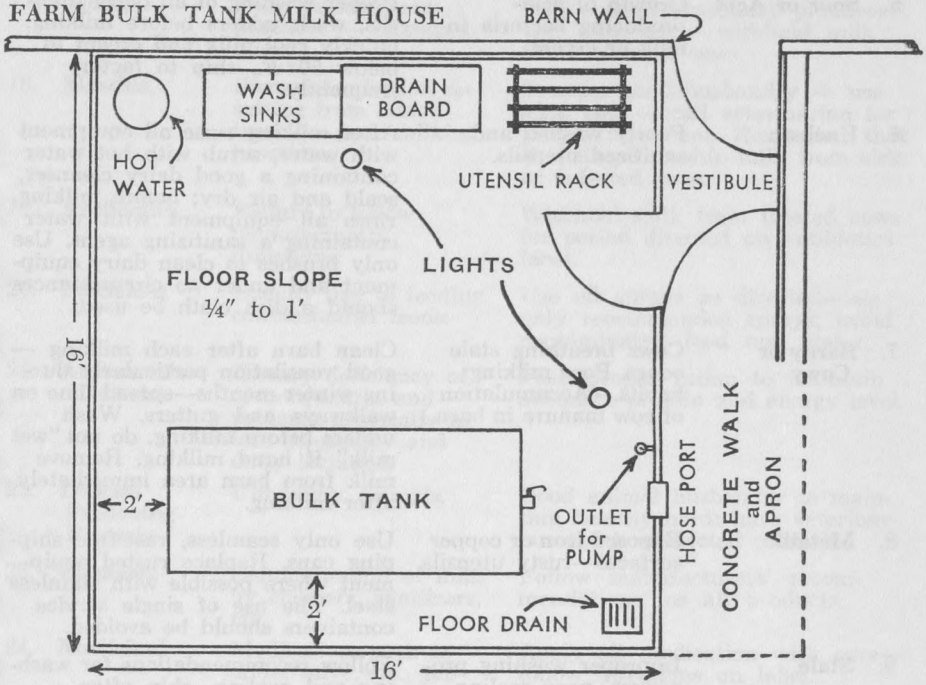
Two systems of refrigeration are used :

1. Ice Bank and
2. Direct expansion of the refrigerant.

The Ice Bank system requires the compressor to work 80 to 90 per cent of the time. With the direct expansion type, the compressor is larger and works for only 25 to 30 per cent of the time. The direct expansion unit costs more than the ice bank type but direct expansion is less costly to operate because the ice bank type also has a circulating pump.

Milk comes into the tanks at between 92 to 98° F. Most tanks cool the first milking down to approximately 36° F. in 1½ to two hours. Subsequent milkings are cooled more rapidly because there is a greater surface area of the cooler to operate and because the existing cool milk acts as a reserve of cold. The maximum temperature of the blend will be about 45 to 50° F.

FARM BULK TANK MILK HOUSE



MILK & CREAM

Taints & Defects — Causes & Remedies

DEFECT	CAUSE	REMEDY
1. **Feed Flavors**	Feeds eaten by cow:— e.g. succulent feed such as rye, beet pulp, crested wheat grass, silage, and clover.	Avoid strong feeds three or four hours before milking.
2. **Weed Flavors**	Weeds eaten by cow:— e.g. stinkweed, mustard, garlic, onion.	Avoid weedy pastures and feeds, including some screenings, particularly before milking. If weeds have been eaten, remove cows to clean pasture or feed good quality roughage three to four hours before milking.
3. **Salty**	Cows late in lactation. Mastitis.	Determine animal causing off-flavor and dry it up—withhold milk from mastitic cows from market (see #18).
4. **Bitter or Rancid**	Poor quality feeds, milk exposed to sunlight, excess agitation of warm milk, milk exposed to copper or iron surfaces, mixing warm and cool milk or cream, cows late in lactation period.	Feed quality roughage, avoid excessive agitation of warm milk and cream, milk contact surfaces should be stainless steel, well tinned iron or copper, or glass. Cool milk or cream before adding to previous milking (this does not apply in bulk tanks).

5.	**Sour or Acid**	Growth of acid-producing bacteria in milk or cream.	Proper washing of all dairy utensils, wash udders before milking, quickly cool milk and cream to below 50° F., ship to factory frequently.
6.	**Unclean**	Poorly washed and sanitized utensils.	After milking rinse all equipment with water, scrub with hot water containing a good dairy cleanser, scald and air dry; before milking, rinse all equipment with water containing a sanitizing agent. Use only brushes to clean dairy equipment and under no circumstances should a dish cloth be used.
7.	**Barny or Cowy**	Cows breathing stale odors. Poor milking habits. (Accumulation of cow manure in barn.)	Clean barn after each milking — good ventilation particularly during winter months—spread lime on walkways and gutters. Wash udders before milking, do not "wet milk" if hand milking. Remove milk from barn area immediately after milking.
8.	**Metallic**	Exposed iron or copper surfaces—rusty utensils.	Use only seamless, rust-free shipping cans. Replace rusted equipment where possible with stainless steel. The use of single service containers should be avoided.
9.	**Stale**	Improper washing procedure, poor cooling, inadequate storage facilities, delayed shipping.	Follow recommendations for washing and cooling—ship often.
10.	**Cheesy**	Due to bacterial growth in cream.	Follow recommended management practices (see 5 & 6).
11.	**Yeasty**	Due to growth of yeasts in cream.	Follow recommended sanitary procedures (see 5 & 6).
12.	**Musty**	Storing milk or cream in musty, poorly ventilated basements, wells, etc. Stagnant drinking water and old musty feed.	Store milk or cream in well ventilated locations—preferably use mechanical refrigeration—provide good quality feed and fresh drinking water for cows.
13.	**Oily**	Odors picked up from gasoline, kerosene, exhaust fumes, separator oil, etc.	Store milk and cream away from all sources of contamination (this is a 'Reject' flavor).
14.	**Refrigerator**	Milk and cream pick up flavors from fruits, vegetables, etc., stored in refrigerator.	Store milk and cream separately from other foods, or in containers with tight fitting covers.
15.	**Flat**	Water dilution — poor nutrition—low fat and solids.	Prevent entry of water — better feed — eliminate low testing cows.
16.	**Sediment**	Wind, dirty udders and flanks — careless methods.	Clip flanks and udders, wash udders before milking. Protect milk or cream from dust during hauling. **Produce clean milk — not cleaned milk.**

17.	**Bloody**	Poor management practices — damaged udders.	Follow good husbandry practices. Use strip cup — withhold milk from affected cows.
18.	**Mastitis**	Bacterial infection resulting from udder injury — poor milking practices.	Practise good husbandry — use strip cup — call veterinarian for proper treatment. Remember that it is illegal to ship milk from sick or infected cows.
19.	**Antibiotics**	Failure to follow manufacturers' directions.	Withhold milk from treated cows for period directed on antibiotics label.
20.	**Pesticides**	Usually due to feeding contaminated feeds.	Use all sprays as directed—use only recommended sprays, avoid contaminated feed and water.
21.	**Acetonemia (Ketosis)**	Dietary deficiency of carbohydrates and proteins, especially in late pregnancy and early lactation.	Feed proper ration to maintain adequate protein and energy level.
22.	**Disease Producing Bacteria**	Unhealthy animals.	Good animal husbandry to maintain healthy herd: have veterinarian check suspected animals.
23.	**Chemical**	Contamination of milk by cleaners, sanitizers, etc.	Follow manufacturers' recommendations for all products.
24.	**Medicinal**	Medications such as udder salve, etc., getting into milk. (Carbolic.)	Apply all medication with care—follow directions on label.
25.	**Frozen**	Failure to use proper cooling methods.	Rapidly cool milk and cream to below 50°. Don't depend on nature for cooling—use mechanical refrigeration. Don't store milk or cream in a freezer—protect from extreme temperatures during delivery.

FACTORS CAUSING VARIATIONS IN BUTTERFAT TEST

Milk :

(a) Heredity — breed and individuality of the cow.
(b) Physiology — age, condition and stage of lactation.
(c) Environment — season of the year and time of freshening.
(d) Management — completeness of an interval between milkings. Exercise and feed.
(e) Miscellaneous factors—health of cows and farm use of milk and cream.

Cream :

(a) Butterfat test of the milk.
(b) Position of cream or skim milk screw.
(c) Temperature of the milk.
(d) Use of slime clogged separator bowl.
(e) Rate of inflow to bowl.
(f) Speed of separator — voltage changes affect speed of power separators.
(g) Amount of flushing of separator bowl.

FARM PROCESSING MILK AND CREAM

Manufactured Products :

A commercial market for farm-made dairy products is practically nonexistent. With the ready availability of factory manufactured butter and cheese, it is not economical or practical to consider the farm manufacture of such products for household use unless proper equipment and storage facilities are available.

Home Pasteurization of Milk :

Rural families can provide themselves with a safe milk supply. Although cows may be T.B. tested and Brucellosis free, this is no guarantee that the milk is safe from disease-producing bacteria. To insure adequate protection, all milk should be heat-treated. The familiar household double boiler is suitable for this purpose. The milk should be stirred occasionally as it is being heated up to 160° F. determined by an immersible thermometer. After reaching the desired temperature, the milk should be cooled immediately in cold water and placed in a properly sanitized container in the household refrigerator.

Several types of electrically operated home pasteurizers are available and may be secured from dairy supply or mail order houses.

Use of Dairy By-Products on the Farm :

Cream shippers have a valuable food product in skim milk. Well cooled skim milk produced under strict sanitary conditions is an excellent food for regular table use, especially if pasteurized. (See section on "Home Pasteurization of Milk".) As a feed for calves, hogs and poultry, it is one of the best farm produced feeds when used as a supplement to grains. To evaluate skim milk as a feed, keep in mind that on the basis of protein alone "1,200 pounds of skim milk is equal to 100 pounds of high protein supplement (35%)". In addition, skim milk contains vitamins and minerals both of which are valuable to the growth and well being of young animals.

Buttermilk and whey, which are available to those farmers residing in the vicinity of creameries and cheese factories, provide a cheap source of excellent feed for pigs and poultry. Buttermilk is equal to, while whey is considered to be half the value of skim milk. To feed these by-products successfully, it is important that they be fed fresh with little or no increase in acidity, or allowed to sour. Wide variations in the method of handling buttermilk and whey are reported to result in serious digestive difficulties.

ALBERTA'S FROZEN FOOD PLANT INDUSTRY

Legislation Affecting Patrons

The Alberta Frozen Food Act and Regulations

- — Provides for the licensing and inspection of all plants that process products for the use of locker patrons and home freezer owners.
- — Requires that satisfactory temperatures be maintained for the chilling, aging, sharp freezing and storage of food products.
- — Makes provision for sanitary plants and equipment in the processing of foods for freezing and storing.
- — Requires satisfactory packaging, materials and methods of wrapping of all food products for storage.
- — Requires adequate insurance to cover patrons' products while in custody of operator.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Two Minutes to Wash Cream Separator	99	410/13-10
Cleaning and Sterilizing Milking Machines	93	410/13-11
How About Your Milk Test ?	87	410/14
Your Cream Test Goes Up and Down—Why ?	6	410/14-1
Preserve by Freezing	313	200/74
Better Cream Means Better Butter	179	410/13-16
Quality Milk Pays and Satisfies	173	410/13-2
Queen's Printer, Edmonton		
The Dairymen's Act and Regulations	—	——
The Frozen Food Act and Regulations	—	——
The Milk Control Act	—	——
Alberta Department of Public Health		
Regulations Respecting Fluid Milk	—	——
University of Alberta		
Immersion Cleaning of Milking Machines	Joint Series 159	410/13
Canada Department of Agriculture		
Care of Farm Dairy Equipment	627	410/13-1
High Quality Milk	844	410/13-3

POULTRY

Poultry production in Alberta is becoming more specialized with increasing numbers of farmers depending upon poultry for their main source of farm income.

COMMERCIAL EGG PRODUCTION

Land Requirement

Where replacement stock is brooded and reared indoors, the amount of land required is no more than that necessary for the buildings and perhaps some allowance for future expansion. If, however, the rearing program involves the use of range, enough land should be available for range rotation. This is necessary for the prevention of disease. The lighter the soil and the better the drainage, the less land required. About 20 acres, divided into three ranges of equal size, should prove adequate for raising 2000 pullets.

BUILDINGS

General type and location — In general, three types of buildings are required: brooder houses, range shelters, and laying houses (see references).

Size Of Flock

Poultry cost surveys indicate that, for most efficient use of labor, farm flocks should consist of not less than 500 birds. An individual intending to earn his total income from a laying flock should keep at least 5,000 layers.

Stock

Breed — The important breeds might be divided roughly into egg-laying, general-purpose, and meat-type breeds.

Single Comb White Leghorns and strain crosses of same have attained wide acceptance by commercial egg producers. More pureline White Leghorns and strain-cross White Leghorns are sold in Canada than any other breed. This is because the Leghorn excels most other breeds in egg production, efficiency of feed conversion, fertility, and hatchability. The Leghorn lays white-shelled eggs.

The general-purpose breeds are good producers of eggs and meat. They are fairly popular on general farms. Of the general-purpose breeds, the most important are the Light Sussex, New Hampshire, and Barred and White Plymouth Rocks. These breeds lay brown-shelled eggs.

The meat-type breeds are discussed under broiler production.

Quality — The best of feeding and management will not make birds produce if they do not have the ability within them to do so. Therefore, the poultryman should seek stock that possesses the inherent ability to produce eggs of high quality through the laying year.

Number of chicks to buy — For replacement, this will depend on the percentage of the laying flock to be replaced. It also will depend on expected mortality during the growing period, and the quality of stock obtained. It is customary to purchase about 2½ times as many mixed chicks or about 1¼ times as many sexed pullets as the number of layers one wishes to house in the fall.

When to buy chicks — To take advantage of high fall egg prices, replacement chicks should be purchased in February or March. However, producers who are concerned with continuity of egg supply find it advantageous to replace ⅓ of the laying flock every four months rather than the entire flock once per year.

BROODING AND REARING

Brooding Facilities

Two types of houses are commonly used : colony or portable brooder houses and permanent brooder houses.

Colony System

The colony system involves the use of small portable houses located about 200 feet apart on range. These are moved at three or four week intervals during the rearing period.

Brooder houses vary in size and shape, but in general are 10' x 12', 10' x 14', or 12' x 12' in dimensions (see references). Houses larger than this should be avoided because they are difficult to move.

Colony brooder houses are usually heated with coal, oil, or propane gas. However, when drawn in close to the other buildings, they often are heated with natural gas or electricity.

A 10 foot by 14 foot brooder house is suitable for starting 250 to 300 chicks. More than 300 chicks in a house of this size will result in overcrowding and poor rate of growth, lack of uniformity, smothering, cannibalism, or disease.

The colony system, when properly managed, is very satisfactory. Green range and sunlight tend to lessen nutritional deficiencies and reduce disease hazard. Rotating the range for use only one year in three and frequent moving of the houses during the brooding and rearing period results in a decrease in exposure to infection. The result is that range-reared birds are usually hardy, vigorous, and have a good reserve of nutrients when they are moved into the laying house.

The permanent brooder house resembles a laying house in construction (see references). They are usually 20 feet to 50 feet wide and vary in length up to about 200 feet. The use of the permanent brooder house system has become more common where brooding is not confined to a single season of the year.

Permanent brooder houses are usually heated to 70° to 75° F by natural gas or propane-fired forced-air furnaces. Brooding heat is supplied by hot water, gas or electric brooders, or infra-red lamps.

RANGE HOUSES AND EQUIPMENT

Range houses are usually of "A"-type or open-front construction (see references) and are used for chickens that no longer require artificial heat. Range houses should be equipped with roosts with wire underneath or slatted floors. Self-feeders and waterers also should be provided.

FEEDING AND MANAGEMENT OF CHICKS

Cleaning — The brooder house should be thoroughly cleaned before the chicks arrive. Start with the removal of litter and droppings. Wash down the ceiling and walls to ensure that all dirt and dust are removed. The floor, if of wood, should be soaked and adhering litter and droppings removed by scraping and sweeping. Next, the floor should be treated with lye solution (one can of lye to five gallons of water), allowed to soak overnight, and finally scrubbed and washed with water. After the house has dried, it should be thoroughly disinfected. The house should be disinfected until it is thoroughly cleaned because disinfectants are relatively ineffective on dirty surfaces. All equipment also should be thoroughly cleaned and disinfected. Following this, the house should be given a coat of whitewash (see references).

Brooder operation — The brooder stove should be put into operation at least three days before the chicks arrive. See that a proper chimney jack, if required, is used. See that the floor is protected against fire by a sheet of hard asbestos or other fireproof arrangement. Check to see that the stove is operating properly and that the temperature can be regulated. The brooder should be capable of maintaining a temperature of 95° to 100° F at the edge of the hover two inches above the litter.

As the chicks age, they require less heat. The initial brooding temperature of 95° F should be reduced about five° F per week until it is down to 60° to 65° F when the chicks are five to six weeks of age. The behaviour of the chicks is the best guide to temperature. If they are cold they will chirp and huddle under the hover, while if they are too warm they will move away.

Litter most commonly used in the prairie provinces are wheat straw, shavings, peat moss, or a combination of these.

During the first week of brooding, the litter under the hover should be removed daily. Later, weekly cleaning will suffice and when the birds are outside most of the day, cleaning every two weeks will be adequate. Daily stirring of litter is recommended and water spillage should be kept at a minimum.

Floor space requirements — Approximately ½ square foot of floor space per bird should be provided to four weeks of age and one square foot from four to eight weeks of age. With chickens in confinement, the floor space should be increased to two square feet per bird at 12 weeks of age and to 2½ square feet at 16 weeks of age.

Ventilation — During the first few days of brooding, little ventilation other than that provided by opening and closing the door is needed. As the chicks age more ventilation should be provided by opening the windows or by mechanical ventilation. On sunny days, sufficient ventilation should be provided to avoid overheating.

Feeders and waterers — From day-old to three weeks of age, chick-size feeders should be used. There should be one foot of feeding space for each 10 to 12 chicks. At three weeks of age, intermediate-size feeders should be introduced and the feeding space doubled. Mechanical feeders may be employed when chicks are two weeks old.

At the start, four one-gallon fountains will supply the water required by 250 to 300 chicks. Initially, they should be placed on the floor. But as soon as the chicks learn to use them they should be placed on low wire stands. This is to prevent the chicks from coming in contact with the damp litter which is usually found around fountains.

At three to four weeks of age, larger fountains or automatic waterers should be introduced. Water supply is extremely important. In the past few years it has been noted that heavy mortality has occurred on farms where the drinking water is very hard. The water supply should be tested for hardness before being used for poultry.

Feeding — Use chick starter until chicks are six weeks of age. Provide chick-size insoluble grit as an aid to use of the feed and development of the gizzard.

From six weeks to sexual maturity, the birds should have access to growing mash (or concentrate) and grain and oyster shell on a free-choice basis. The chick-size grit should be replaced by intermediate-size grit.

Feed consumption — Two pounds of starter for each chick purchased should take care of the feed needed to six weeks of age. At this time the chicks are usually placed on growing feeds. Twenty to 25 pounds of feed are required to raise a pullet from six to 20 weeks of age.

Early roosting — Forcing roosts should be lowered when the chicks are three to four weeks old. The chicks then should be driven up on the roost each night until they go up of their own accord. Losses from smothering are less apt to occur if the chicks are roosting properly.

Getting chicks out of doors — In the colony system of brooding, weather permitting, get the chicks outside on clean land by the time they are four to six weeks of age.

Range crops — Annual crops such as oats or rape or perennial grasses and lugumes such as alfalfa or clover provide good range for poultry.

Moving brooder and range houses — The colony brooder houses or range shelters should be moved at least once a month in order not to over-contaminate the range in one area and to avoid killing the grass under the houses.

THE LAYING FLOCK

Housing

The laying house should be designed to provide maximum comfort for the birds throughout the laying year (see references).

Floor space — Heavy breeds should be allowed two to three square feet of floor space per bird and light breeds 1½ to 2½ square feet.

EQUIPMENT

Labor required for feeding and watering the birds, gathering the eggs, and cleaning the house can be minimized by :

1. Installing automatic waterers, either pressure or gravity.
2. Using automatic feeders — if this is not feasible use hanging or other types of feeders so that feeding may be done quickly and conveniently.

3. Arranging the nest close to the door so as to reduce the time required to gather eggs.

4. Screening off dropping boards or using dropping pits; using the deep-litter system of litter management;

5. Make provision for feed storage in the buildings.

Nests — Some operators prefer individual nests while others prefer community-type nests. Individual nests are usually about 12" to 14" wide, 14" high, and 14" deep. One such nest should be provided for each five to six layers. Community nests 2' x 4' or 2' x 6' are common. A community nest 2' x 4' should be provided for each 50 layers.

Feeders — High-producing flocks should have at least 33 linear feet of feeding space per 100 birds. Feed troughs for laying birds should be about 18" off the floor and should have reels to keep the birds out of the feed. The troughs are usually about 6" deep and 8" wide, have flat or V-shaped bottoms, and a lip to reduce feed wastage.

A recent trend in larger flocks has been towards the use of automatic feeders but these are not economical in flocks of less than 1,000 birds.

Feed storage — A feed bin should be provided in the building.

Waterers — The use of automatic waterers in the laying house is desirable and will greatly reduce the labor required. If these are not employed, use sufficient water fountains or troughs to supply three to five gallons of water per 100 birds per day. Waterers should be placed on stands or over the dropping pits if the pits are present.

Perches — These should be built in sections that may be easily raised to make cleaning of the dropping boards or pits easy. They may be made of 2" x 2" material, rounded on the edge, and set 13" to 15" apart. Six to 8" of roosting space should be allowed for Leghorns and 10" to 12" for heavies. The perches should not be more than three feet above the floor.

Either dropping boards or dropping pits may be used in conjunction with the perches. Dropping boards are generally built in sections and are located about 30" above the floor. Dropping pits are usually about 18" deep.

Whether dropping boards or dropping pits are used, they should be screened off to keep the birds away from the droppings. Fourteen gauge 1" x 2" mesh welded wire or 2" hexagonal wire (16 gauge) is very satisfactory for the purpose.

MANAGEMENT OF THE LAYING FLOCK

Cleaning — Before the pullets are moved into the laying house the equipment and the house should be cleaned, scraped, and washed with water. The floor should be scrubbed with a lye solution (one can lye to five gallons water). The floor should be allowed to soak overnight, and washed with water. Finally, the building should be disinfected by spraying with a good disinfectant and whitewashed.

Litter — Wheat straw is satisfactory and is usually available at a low price. Shavings or peat moss or a combination of these may be used, but are usually more expensive than straw. Shavings do not absorb much moisture and need to be changed more often. Peat moss has a much greater moisture holding capacity than either straw or shavings. But it is expensive and tends to become dusty.

There are two common methods of managing the litter. The conventional method has been to keep the floor of the laying house well covered with clean dry litter which is changed every two weeks during the winter and once a month during the summer.

A newer method of litter management that has received wide acceptance in commercial flocks is "deep-litter" or "built-up" litter. Four to six inches of litter is placed in the laying house prior to housing the pullets. It is usually done in August or early September so that fermentation will commence before the weather becomes too cold. Clean litter is added at intervals until the litter is eight to 10 inches deep. The litter should be stirred regularly. Under this system, the litter, if properly handled, needs to be changed only once a year. If the litter becomes wet, the addition of hydrated lime is recommended at the rate of about 10 pounds per 100 square feet of floor area. The hydrated lime should be stirred into the litter.

Time of housing — The pullets should be housed as they are coming into lay. Continue the same feeding practice that was used on the range for a few days until birds become accustomed to the new quarters.

Artificial illumination — This is used on the laying flock to stimulate egg production. One 40-watt bulb, equipped with a reflector, six feet above the litter may be used for each 200 square feet of floor space. In houses up to 24 feet wide, a single row of lights is satisfactory. But in houses wider than this a double row of lights should be used.

The use of sufficient artificial light is to give the birds a 13 to 14-hour light-day. This is usually started in the fall when the pullets reach their peak of production. It is continued until spring when the lengthening of the hours of daylight eliminates the need. Lights should also be used at the end of the laying year to prolong production. Following the annual moult lights bring layers back into production.

FEEDING THE LAYING FLOCK

The all-mash system — In this system the entire ration is fed in ground form. No whole grain is fed. With this method there is less likelihood of hired labor making a mistake.

Mash Disadvantages

The chief disadvantages of the all-mash system of feeding are :

1. All of the ingredients have to be ground.

2. There is sometimes a tendency for pullets to lose weight in the fall when they come into peak production.

3. If the loss in weight is not checked, some of the birds are likely to go into a pause. This may be avoided by increasing the proportion of high-energy feeds such as wheat. At the same time decrease the proportion of oats, barley, and mill by-products in the laying ration. The litter and dropping boards tend to be wetter when an all-mash ration is fed than when a mash-grain or concentrate-grain system is used.

The mash-grain system — This involves feeding a laying mash (containing about 18 per cent protein) with scratch grain. Laying mash may be purchased ready-mixed. It may also be made by mixing 100 lb. of 35 per cent protein laying-mash concentrate with 300 lb. of grain (150 lb. ground wheat, 75 lb. ground oats, and 75 lb. ground barley).

A suggested schedule of feeding is as follows :

Keep laying mash (18 per cent protein) in front of the birds at all times. Feed 12 lb. of scratch grain (two parts wheat, one part oats by weight) per 100 Leghorns, or 13 lb. per 100 heavies per day (one-third of this may be fed in the morning and ⅔ in the evening about an hour before the birds go to roost).

The concentrate-grain system — In this system, laying concentrate (usually pelleted) is fed along with scratch grain. The system permits maximum use of home-grown grains which not only do not have to be ground but may be self-fed in hoppers.

The main disadvantages of the system are :

Feed efficiency is reduced slightly.

Individual birds may consume different proportions of grain and concentrate resulting in variability in yolk color. If concentrate and grain are fed in separate hoppers on a free-choice basis the birds tend to consume a higher level of protein than is necessary to maintain a high rate of egg production. Since protein is an expensive part of the ration, this increases the cost of egg production.

Regardless of the feeding system employed, oyster shell, insoluble grit, and clean water should be available to the birds at all times.

Feed consumption — The amount of feed required for a laying hen is dependent on a number of factors. These include the weight of the bird, the rate of egg production, and the energy content of the feed. In general, the larger the bird, the more feed is required for maintenance. As the rate of production increases, extra feed above that required for maintenance is needed for egg formation. In addition, the feed required per bird per day is more or less directly related to the productive energy content of the ration. Thus, on high-energy

rations (rations high in wheat and low in oat and barley content) proportionately less feed is eaten than on lower-energy rations (rations low in wheat and high in oat and barley content). This factor may be of considerable practical importance to the producer.

A high-energy feed, though more expensive per pound, may result in lower production costs than can be obtained on a low-energy feed. Value of a feed should not be based on the cost per ton. It should be based on the cost of feed required to produce a unit of product, such as a dozen eggs or a pound of poultry meat.

Caged Layers

In recent years, the keeping of layers in cages has become quite popular in Alberta. The following advantages are claimed for the cage system over the floor system.

1. Increased housing capacity.
2. Lower mortality.
3. Less cannibalism.
5. Ease of maintaining plant at full capacity the year-round.

However, the cage system has some disadvantages as compared to the floor system. These include: greater investment in equipment; higher percentage of soiled and cracked eggs and a more serious fly problem.

Cage Types

Numerous types of cage installations are available commercially. Some cages are designed to hold one bird, others two or more birds. Some installations are single-tier, others two-tier. Two-tier completely offset multiple bird cages and are perhaps the most popular. Cleaning of such installation is usually accomplished by providing a concrete trough equipped with a mechanical scraper under the cages. Feeding may be done by a mechanical feeder or by running a feed wagon up and down the aisles between the rows of cages. Water is usually provided by small V-shaped troughs with automatic filling devices. Eggs may be belt-gathered or collected by hand using the feed wagon for the transport of gathered eggs.

Birds in cages are generally fed an all-mash or crumbled laying ration containing about 16 per cent protein. Some operators feed supplementary oyster shell, although this should not be necessary if the ration is properly balanced with respect to calcium and phosphorus content. The feeding of insoluble grit once a week will tend to improve feed utilization and prevent gizzard impaction.

Lights should be provided down the aisles between the rows of cages. About one foot candle power of light should be provided at the feeders. A 12 to 14 hour light-day is recommended.

Fan ventilation is a must in cage operations. This, of course, is because 1½ times as many birds may be housed in cages in a building as may be comfortably accommodated on the floor.

THE LAYING FLOCK

Production of Quality Eggs

To make a success of egg production, it is necessary to pay careful attention to the matter of egg quality. Everything possible must be done to insure that the eggs produced will be of the highest quality possible. No effort can be spared to insure that this quality is maintained right up to the time the eggs reach the consumer's table.

The strain of birds is one of the factors affecting the production of quality eggs. Certain strains of birds produce eggs of higher interior quality than other strains. Another factor which has a definite bearing on the quality of the eggs produced is the age of the bird. Egg quality deteriorates as the age of the bird increases. Therefore, birds that have been in production for 10 to 12 months or birds late in their second year of production will likely be producing eggs of lower quality.

Proper feeding is, of course, necessary to produce top quality eggs. Special attention must be given to insure that adequate amounts of protein, Vitamin A and D and calcium are included in the ration. Other practices which must be followed to insure top egg quality include the exclusion of males from the pens (except for production of hatching eggs). Laying birds should be confined at all times.

Every effort should be made to keep eggs clean. Nests should have adequate amounts of clean nesting material and cage trays and belts should be kept clean. Finally, eggs should be gathered often.

Retention of Egg Quality

Production of quality eggs will be of no avail unless that quality is maintained throughout the life of the egg. Temperature and humidity are the main factors which control the rate of quality deterioration in eggs. For this reason, eggs should be cooled as quickly as possible after laying. They should be held at about 50° F with humidity kept up to 60 to 70 per cent. The high humidity retards the rate of moisture loss from the eggs.

Regardless of storage conditions eggs will deteriorate in quality. Therefore, eggs should be marketed as often as possible. Eggs should always be packed with the small end down. Odors or off-flavors may be picked up if they are present in the egg storage room. Rough handling of eggs will result in cracked and broken shells, in floating air cells and lowered interior quality. All this decreases the producer's return for his eggs. Many producers are now spray oiling their eggs on the farm in an attempt to preserve egg quality.

CHICKEN HATCHING EGG PROBLEM

The feeding and management of hatching egg flocks is similar to that outlined for commercial egg flocks. There are, however, certain aspects which do differ from commercial egg production.

Costs Involved in Hatching Egg Production

It costs more to produce hatching eggs than commercial eggs. Some of the extra costs are as follows: Breeders' mash is usually slightly higher in price than laying mash. There is a cost involved in the banding and blood testing of breeders. Replacement pullets often are more expensive than straight commercial stock. Males cost money — and to the purchase price of the males, less their salvage value, must be added the value of the eggs that a like number of pullets would have produced. Another cost which may be a factor is that the hatching egg market may demand that a producer keep a female line that is not too efficient as an egg producer. Such birds may be used in a strain cross.

There are certain additional risks involved in hatching egg production. These include a drop in production during the hatching season, disease which might exclude shipment of hatching eggs, per cent hatch and length of season.

Possibly one of the main costs to consider is the probable loss of special year-round commercial markets in favor of a few weeks of hatching egg production. Producers often find that these premium markets are no longer available after the hatching season is over.

FEEDING AND MANAGEMENT

The hatching egg flock should be fed a breeding ration rather than a laying ration. Feeding of the breeding ration should commence about six weeks prior to breeding and continue through the breeding season. Any of the systems of feeding for laying birds may be followed. However, the best control of nutrient intake is obtained by the all-mash method.

Fertility — In order to obtain a high per centage hatch, good fertility is necessary. Strong vigorous cockerels should be used. Care should be exercised that they do not get their combs frozen. This will result in low fertility. In flock matings, one male for 12 to 15 females is used in heavy breeds. One male for 15 to 18 females in light breeds is adequate.

The males should be placed in the pens about 10 days before collecting eggs for hatching. They may be removed a week before the end of the hatching season without loss of fertility.

Care of Hatching Eggs

Care of hatching eggs is similar to that of market eggs. The eggs should be collected frequently and held at 55° - 60° F. Humidity is also important and an effort should be made to maintain high humidity in the egg room. Only sound shelled eggs of suitable size and shape should be shipped to the hatchery. Extremes of temperature, either hot or cold, can drastically reduce hatchability. Both should be guarded against during storage and shipment. Again, eggs must be trayed with the small end down and handled with care. Rough handling reduces hatchability.

Where egg washers are used, every effort must be made to insure that they are operated in accordance with the manufacturers' directions. The water must always be warmer than the eggs to be washed and should never be allowed to get too dirty. Here too, no effort should be spared to produce clean eggs. Eggs should always be set as quickly as possible after production. Even under ideal storage conditions hatchability declines rapidly after one week to 10 days.

BROILER PRODUCTION

Size of enterprise — It is generally considered that marketing at least 50,000 broilers a year is necessary to ensure a satisfactory income from broiler raising.

Type of operation — Broilers are marketed at eight to 10 weeks of age at an average weight of 3½ to four pounds. Usually they are raised in houses of 5,000 to 10,000 with four or five marketings a year. This permits a thorough cleaning of the premises between each batch of broilers and prevents disease better than the continuous type of operation where a new lot of broiler chicks is started each week. The latter system, however, yields a more regular supply, which may be desirable under certain circumstances. Under no circumstances should birds of different ages be kept in the same house.

Broiler chicks — A white broiler is a must. The majority of broiler chicks sold today come from crosses involving dominant white Cornish-type males mated to meat type females. The latter consist largely of special meat strains of White Rocks. Chicks of this type, under proper feeding and management, are capable of averaging 3.5 pounds in weight at nine weeks of age with a feed requirement of 2.5 pounds of feed per pound of gain.

Housing and equipment — Broiler houses are generally of the permanent brooder house type, ¾ - one square foot of floor space being provided for each broiler. Houses should be force ventilated, equipped with mechanical and/or hanging feeders, automatic waterers and, of course, with brooders. Some auxiliary heat also is necessary to facilitate the maintenance of proper temperatures, 60° to 70° F., in the house.

Brooding — See details under brooding for commercial egg production.

Feeding — Broiler chicks should be fed a high energy broiler ration containing approximately 22 per cent protein until they are six or seven weeks of age. Then they should get a high-energy finishing ration containing approximately 19 per cent protein until they are ready for market.

TURKEY GROWING

Size — It is generally considered that 5,000 or more turkeys must be raised to ensure an adequate income from turkey growing.

Type of operation — Turkeys, traditionally, were raised on open range. However, recently many growers have adopted confinement rearing in sheds. Very often fenced yards are used to increase the capacity of the houses. Under the rotational range system one acre should be provided for each 100 to 200 turkeys raised. In the confinement method four to six square feet of floor space is provided for each turkey.

Type of poult — The Broad-Breasted Bronze turkey has been the traditional favorite of Alberta producers. In recent years, however, the Large White is becoming increasingly popular. Small Whites are also increasing rapidly in popularity as the turkey broiler industry becomes more firmly established.

Housing and equipment — The brooding accommodation and equipment required is similar to that required for large scale chicken brooding. Range shelters may be of cheaper construction than for chickens since all that is needed is protection from wind and storms. Range equipment should consist of large self-feeders, automatic waterers and low movable roosts made from two-by-fours, flatwise, spaced about two feet apart.

Brooding and rearing — See details under brooding and rearing of chicks for commercial egg production.

Feeding — Poults should be started on a 28 to 30 per cent protein, high energy vitamin fortified starter for 10 days. They should then be transferred to a 26 per cent protein starter until they are eight weeks old. Then they should be fed an 18 to 20 per cent protein growing feed in mash or pellet form plus whole

grain. As an alternative, growing concentrate in mash or pellet form plus whole grain may be fed. As soon as the feeding of whole grain is commenced, the birds should have access to oyster shell and insoluble grit. Four to six weeks prior to marketing, the turkeys should be fed a 13 to 14 per cent protein, high energy fattening mash as the sole feed. It takes approximately 100 pounds of feed to raise a turkey to market age.

Marketing — Females are generally marketed when they are 22 to 24 weeks old and toms when they are 26 - 28 weeks old.

TURKEY BROILER PRODUCTION

Traditionally, a small Beltsville white turkey was used almost exclusively for broiler production. More recently, there have been other heavier strains of white broiler turkeys developed. There is also the trend, at present, to kill off large white and even bronze hens at broiler weights. This is, of course, done only when the broiler market price appears more favorable than the heavy turkey price. The toms are usually left and finished out as heavy turkeys. The principles involved in brooding, rearing and feeding are similar to those outlined for chickens. About three square feet of floor space per bird is required for confinement rearing. Turkey broilers are generally sold at 12 to 16 weeks of age weighing from 10 to 12 pounds.

TURKEY HATCHING EGG PRODUCTION

For this purpose poults are brooded and reared in much the same manner as outlined under "Turkey Growing". Prospective breeders should be selected when 20 to 22 weeks of age. From this time until the birds are placed in the breeding pens the prospective breeders should be maintained on a low energy type ration. Four to six weeks before mating, the toms should be subjected to 12 to 14 hours of light so they will be sexually active when placed with the hens. From this time on both toms and hens receive light. When the hens are mated the birds should be placed on a breeding ration and be fed oyster shell and insoluble grit free choice. Any of the systems of feeding referred to under the feeding of laying birds may be followed. However, the best control of nutrient intake is obtained by following the all-mash method.

Artificial insemination is recommended. Broodies should be placed in a broody pen as soon as detected and left there for three to five days to break them of the habit. While in the broody pen, feed the regular ration. Eggs should be collected and handled in much the same way as outlined under Chicken Hatching Egg Production.

REFERENCES

	Bulletin No.	Agdex No.
Alberta Department of Agriculture		
Plans for Laying Houses		721.5-17
Poultry Plans Catalogue		713/450
Two Whitewash formulas	55	784
Broiler Production	133	452/24
Turkeys	1	453/20
University of Alberta		
Diseases of Poultry	45	669-6
Poultry Production in Alberta	61	450/01
Laying House Plan	Farm Plan No. 1	721.5-17
Brooder House Plan	Farm Plan No. 2	721.5-18
Range Shelter Plan	Farm Plan No. 3	722.5-4

LIVESTOCK DISEASES AND PESTS

Control of livestock diseases in Alberta is the responsibility of the veterinary profession which had about 260 members in the province in 1966.

Veterinary Practitioner

The veterinary practitioner is concerned with disease problems at the local level and the treatment of individual animals and herds from diseases of all kinds. In addition, the practitioner is closely involved with provincial and federal disease programs. Without his services many of these programs could not function. About 150 veterinarians are currently in private practice in the province in 93 separate practices. Clinic and hospital facilities are provided by many of the practices and in the cities there are eight hospitals primarily for small animals. In rural areas, 42 clinics are operated for large animal patients.

Veterinary Services Division — Alberta Department of Agriculture

This division employing about 15 veterinarians offers various services to the Alberta livestock producer. Operating under the director and by the authority of the Livestock Diseases Act, it provides laboratory diagnostic services and disease control programs which are constantly under review to meet the changing needs of the livestock industry.

Veterinary Laboratories

A large central diagnostic laboratory is operated by the veterinary division in Edmonton. It provides for the rapid identification of livestock, poultry, wild life and pet diseases from specimens submitted by veterinarians and owners. The services include post mortem, bacteriology, histopathology, parasitology, toxicology, virology and any other diagnostic aid necessary to identify and control disease.

A second laboratory staffed by two veterinarians has recently been opened in Lethbridge to provide a similar service for southern Alberta. In addition, a laboratory similar to the one at Lethbridge was to be built in the Peace River block.

The Edmonton laboratory was to move into modern premises. A still broader range of service will become available to the livestock industry.

Brucellosis Control Programs

Brucellosis, once one of the most serious livestock and human diseases in Alberta, has been virtually wiped out through the co-operative efforts of government and veterinarians. Calfhood vaccination supported by provincial grants made the first great stride in bringing the disease under control. With the cases of the disease at a manageable level, the federal radication program has reduced the disease to insignificant proportions.

Consequently, compulsory vaccination is being de-emphasized. Voluntary vaccination will continue so that the cattle population will continue to resist the disease. Provincial grants continue to be available for this service. A constant lookout for new outbreaks will be maintained by federal authorities through milk ring tests and cull cow testing.

Veterinary Inspection at Stockyards

All animals sold through auction markets in Alberta are inspected for visible signs of disease which might be a hazard to the buyer's herd. This program is very effective in keeping diseased animals out of livestock marketing channels.

Swine Herd Health Program

The veterinary division operates a health program for swine which provides for regular inspection of herds and examination of post mortem materials. Its purpose is to provide a source of breeding stock as close to disease-free as possible. In 1966, over 30 herds were enrolled in the program.

Licensing

The sale of poultry vaccines, livestock medicines and humane slaughter in local abattairs are controlled through regulations made by the Livestock Diseases Act and administered by the Veterinary Services Division.

Extension Activities

The division's involvement in extension work covers a wide field of media and techniques. It includes lectures at the University of Alberta, preparation of bulletins on livestock diseases, preparation of radio and press releases, talks to farm groups and people in allied fields and career counselling at high schools.

In addition, veterinary medicine as a career is encouraged by payment of grants to students attending veterinary schools and by a cost-sharing arrangement with the Western Veterinary College at the University of Saskatchewan.

Common Diseases of Livestock in Alberta

The following disease tables provide a summary of some of the more important disease conditions commonly seen in this province.

The tables are not intended as a complete description of the disease and methods of control, but rather as a guide to livestock men to assist them in recognizing disease in their herds and flocks and to impress upon them the many and varied disease conditions which may be encountered. Livestock owners are strongly urged to contact their local veterinarian when they suspect disease in their animals so that an early and accurate diagnosis can be made and treatment and preventative measures instituted as early as possible.

The laboratory services are available to all livestock producers and their veterinary practitioners. The service provided is free. The livestock owner who uses the services of his practitioner and through him the laboratory service will be in the best position to increase his profits by reducing disease loss.

DISEASES OF SWINE

Disease	Description	Prevention and Control
Losses in suckling pigs	Greatest loss in first four weeks of life. Infectious disease is responsible for only a small part of loss. Vitamin and iodine deficiency in ration of pregnant sows, anemia, chilling from damp, drafty farrowing pens, poor sanitation all are important.	Follow recommended feeding and management practices for pregnant and nursing sows. Sanitation at farrowing time and during the nursing period is vital. Commercial preparations containing vitamins and antibiotics are available for control of uncomplicated scours in nursing pigs. If losses occur despite good management, seek professional help.
Anemia	Nursing pigs receive insufficient iron from sow's milk. If iron is not available, nutritional anemia will develop, causing weak, pale, listless pigs, often accompanied by scours, heavy breathing, and death.	Iron as reduced iron may be administered commencing on the second or third day of life and repeated once or twice weekly for the first three weeks. Injectable iron is very widely used and is quite satisfactory. One or two injections are required.
Enteritis (Scours)	Common during the weaning period and until the pigs are well established on feed. May be due to infection or poor feeding practices and sometimes complicated with heavy roundworm infestation.	Laxative of raw linseed oil (¼ cupful/100 pounds of pig) and light diet gradually return to full feed. Antibiotic supplements helpful but not a substitute for good sanitation. Some cases necessary to resort to medicinal treatment with antibiotics or sulfonamides.
Roundworms	Most critical in small pigs. Adult in intestinal tract produces thousands of eggs which pass out in droppings contaminating pastures, yards and farrowing pens. Eaten by little pigs, hatch, grow to maturity after passing through	Good sanitary practices, including pasture rotation, worm-free sows and clean farrowing pens essential. Routine worming of pregnant sows and pigs at eight to 10 weeks of age is recom-

Disease	Description	Prevention and Control
	liver and lungs. Unthriftiness and coughing are prominent symptoms.	mended. Suitable products are sodium fluoride, cadmium preparations or piperazine. Hygromycin as a routine feed additive also satisfactory.
Erysipelas	Most serious infectious disease of swine. Observed most frequently in pigs over 100 pounds, but will affect all ages throughout the year. Three types, acute, chronic and diamond skin disease. The acute appears suddenly with high fever, pigs prostrate and dying; spreads rapidly. Chronic type is characterized by enlarged joints, crippling and unthriftiness.	Early recognition and prompt treatment essential in acute outbreaks. Consult your veterinarian. Penicillin and erysipelas antiserum used in treatment with serum being administered to all exposed pigs; routine vaccination at eight weeks with erysipelas bacterin.
Enzootic Pneumonia	Characterized by persistent coughing and varying degrees of unthriftiness. Most important in that it may result in severe secondary pneumonia, precipitated by improperly ventilated quarters.	No effective treatment available. Good housing particularly for young pigs will control losses. Vaccination may be helpful where secondary pneumonias are a recurring problem.
Rhinitis	Appears first in nursing pigs causing sneezing, occasional bleeding from the nose with the gradual development of deformed, twisted or shortened snouts, due to alterations in the turbinate bones. May affect only part of a litter but unaffected pigs may be carriers. Seems to be most severe in a newly-affected farm.	No curative treatment. Care in purchase of stock, only from rhinitis-free premises. In majority of cases it is necessary to market all pigs and start again with clean breeding stock.
Pneumonia	Infectious disease, most frequent in colder seasons of the year and in damp, drafty quarters. There is fever, rapid breathing with a distinct thump and a varying number of animals may be affected. Usually not a large number involved at one time.	Isolate sick pigs, make comfortable and treat with antibiotics or sulfonamides. Damp, drafty quarters must be avoided. Administration of some bacterins may be an aid in prevention.
Infectious Serositis	Frequently observed as a disease in litters, vigorous to three weeks of age at which time they begin to do poorly. Coughing, a few enlarged joints, heavy breathing and stunted growth in survivors is characteristic.	Terramycin and some other antibiotics are successful treatment. It is best to consult your veterinarian since it is necessary to follow management practices designed to eliminate or control the infection.

DISEASES OF CATTLE

Disease	Description	Prevention and Control
Vitamin A deficiency	Deficiency observed as weak calves, scours, convulsions and death; blindness and collapse in feedlots.	Adequate amounts of vitamin A in ration of pregnant cows; good quality roughage. The use of commercial vitamin A supplements (to supply 30,000 I.U. vitamin A daily) for pregnant cows and feedlot animals can be highly recommended.
Mineral deficiency	Commonly observed in Alberta particularly phosphorus deficiency in cows with depraved appetite, loss of condition and breeding deficiencies.	Mineral supplements must be used. Expensive complex preparations are not necessary—Don't forget salt.
Calf Scours	Frequently infectious disease complicated by vitamin A deficiency. Can cause very serious losses when contaminated surroundings and improper management practices are present.	Follow recognized feeding and management practices; good sanitation in dairy barns. Commercial calf scours preparations (containing antibiotics and sulfa drugs) are available. Vitamin A is helpful in treatment.
Bloody Diarrhea Coccidiosis	Infectious disease observed most frequently in young beef animals in colder seasons of the year characterized by bloody diarrhea. Frequently fatal.	Suspected diagnosis should be confirmed; sulfonamides or intestinal astringents are used in treatment.
Indigestion	An acute toxemia with depression—coma and death; result of a sudden change of feed, switch to new grain, animals gaining access to open bins or granary. In severely affected animals the outcome is almost always fatal.	Try to avoid circumstances which cause it. Get professional help. The administration of oil, forced exercise and restricted water intake may be helpful.
Bloat	Acute—rapidly developing fatal bloat occurring on lush pasture, particularly legumes. Chronic—observed most often in individual beef animals; not usually immediately fatal. There is still much unknown concerning the true cause of bloat.	Avoid turning hungry cattle on to young lush legume pasture particularly if it is wet. Kerosene in milk, the placing of a gag in the mouth or puncturing the rumen (left side) with torcar and cannula in acute cases; treatment of chronic bloat not often successful.
Blackleg	Acute infectious disease usually of young cattle between four months and two years of age but may affect older or younger animals. Frequently a pasture disease but may occur throughout the year. Animals often found dead, carcass bloated; gassy swellings underneath the skin are often a prominent feature.	Vaccinate calves and yearlings routinely with blackleg-malignant edema bacterin. Calves should be four months of age if good protection is to be afforded.

Disease	Description	Prevention and Control
Malignant Edema	Very similar to blackleg.	As for blackleg.
Feedlot sudden death	Illness usually not observed, but animals found dead. Occasionally, staggering may be seen prior to death. Many areas of doubt regarding this disease.	Obtain professional assistance. Recent evidence indicates Clostridium novyi may be involved and vaccination can be considered.
Shipping Fever	An acute, suddenly-occuring infectious disease of beef cattle usually associated with shipping. High fever, pneumonia, sometimes scours are characteristic.	Try to avoid rough handling. The use of vaccines two weeks prior to shipping may be helpful. Obtain qualified advice in the handling of outbreaks.
Winter Dysentery	Highly infectious and contagious disease usually seen in adult cattle in the winter time and characterized by bloody diarrhea.	Avoid all contact with neighbors' cattle known to be infected. Intestinal antiseptics and astringents useful in treatment but recovery is the rule even without treatment.
Mastitis	Infection of udder of dairy cows with development of flakes, clots and blood in milk; acute flare-ups on occasion with swollen udder. Irritation and damage to udder is a factor in cause.	Follow milking practices and management designed to control mastitis. Early treatment is essential. Don't waste money on repeated treatment of individual cows. Mastitis control programs are available through your veterinarian.
Brucellosis	Infectious disease, causing abortion sterility, retained afterbirth, and transmissible to man. Infected cow main spreader.	Calfhood vaccination, blood testing and elimination of infected cows. Control programs sponsored by both federal and provincial governments.
Vibriosis	Infectious disease characterized by early abortion and repeated breedings. Cows recover but the infected bull, the main spreader, remains so indefinitely.	Must be diagnosed by a veterinarian and control program worked out on the basis of the individual farm concerned. Artificial insemination useful if practical. New vaccine becoming available which may be useful in the future.
Cancer Eye	White faced cattle, small sore on eyelid which will continue to grow until animal dies or is killed.	No treatment, early salvage by slaughter. Surgery may be successfully performed on valuable animals.

DISEASES OF SHEEP

Disease	Description	Prevention and Control
Stiff lamb disease	Nutritional disease in lambs three to 10 weeks of age probably related to selenium and/or vitamin E deficiency. Characterized by stiffness developing into paralysis and inability to stand.	Use of selenium and/or vitamin E particularly where soil deficiencies are known to exist.

Disease	Description	Prevention and Control
Weak Lambs Scours	Losses occur in lambs in their first three weeks of life. Diarrhea, weakness and death usually result. Infectious disease may be involved but nutritional deficiencies and straight malnutrition of ewes during pregnancy is an important factor. Vitamin A deficiency is also frequently involved.	Follow recommended feeding and management practices for pregnant ewes. Vitamin A supplements can be recommended; concentrated fish oil administered to weak lambs at birth. In one highly fatal form bacterins and antitoxins seem to be useful in control.
Internal Parasites Roundworms	Sheep are highly susceptible to a number of types of roundworms, all are serious parasites; in lambs the blood sucking stomach worm will cause heavy death loss; intestinal worms causing diarrhea and loss of appetite are often observed.	Follow a regular parasite control program; worm flock in January; repeat in early summer and fall. Phenothiazine or thiabendazole are both useful products.
Lungworms	Parasite that lives in lungs resulting in persistent coughing, unthriftiness, and death.	Treatment with commercial lungworm preparations — good sanitation important.
Tapeworms	Not as serious as roundworms; may cause symptoms of incoordination or staggering.	Require special treatment; phenothiazine is not effective; excellent commercial preparations available.
Enterotoxemia (Clostridium perfringens)	Infectious disease observed most frequently in lambs on heavy feed; suddenly appearing convulsions, spasms and death; may occur in nursing lambs.	Good practice to vaccinate feeder lambs with a Clostridium perfringens type D bacterin routinely.

DISEASES OF POULTRY

List of Eight Important Diseases of Poultry in Alberta

Disease	Description	Prevention and Control
Leukosis Complex	A virus tumuor type of infectious disease showing up in various forms, e.g., paralysis, enlarged livers, bones; spread by direct contact, aerosols and egg transmission; affects chickens mostly, but can affect turkeys.	Control difficult — raising day-old birds at least 200 yards from old birds assists in reducing incidence.
Avian Tuberculosis	A bacterial infection similar to cattle and human types of tuberculosis; not highly transmissible to people, but highly transmissible to pigs; affects chickens and turkeys.	Sanitary management; no drug treatment effective.
Infectious Bronchitis	A rapidly spreading virus infection of lungs and windpipe of chickens; does not affect turkeys; can cause losses of baby chicks; in adults loss of egg production.	Vaccinate chicks; revaccinate birds producing hatching eggs to ensure temporary parental immunity to offspring.

Disease	Description	Prevention and Control
Coccidiosis	Any intestinal disease caused by tiny, microscopic protozoan parasites called coccidia. These break-down the cells of different parts of the intestinal tract; different types affect turkeys and vice versa.	Maintain litter and surrounding of birds in a dry condition; the use of commercial coccidiostat in the feed or water recommended; several good drugs available for treatment; follow manufacturer's instructions.
Chronic Respiratory Disease	A chronic, slow-spreading infection of lungs, windpipe and air sacs in chickens; also cause swollen sinuses of the face in turkeys. Caused by a microscopic organism called P.P.L.O. possibly with a virus assisting it. Very chronic in nature, "hanging on" in a flock through the life of the birds. Sometimes noticeable as a sneeze or cough and low egg production; may cause fairly high losses in broilers; transmission from bird to bird or through eggs.	None really effective to date. Administration of antibiotics assist in "holding down" symptoms but generally do not cure it; much hope held for the production of P.P.-L.O. - free breeding flocks.
Enterohepatitis (Blackhead)	A highly fatal liver and intestinal infection of turkeys and chickens caused by tiny microscopic protozoan parasites called Histomonads. These generally infect by "hiding" in the body and eggs of the common caecal worm of chickens. Chickens have some resistance, but turkeys are highly susceptible.	Do not raise chickens and turkeys together. Proper range rotation to eliminate worm eggs. Attempt control by drugs fed continually in the feed; this is still very expensive; good drugs available for treatment.
Fowl Typhoid	A serious bacterial infection of poultry (chickens, turkeys, ducks, geese); generally associated with poor sanitation; mostly affects adult birds. Transmission is by direct contact carrying infected manure from farm to farm; or through eggs; in Alberta has been confined to the area east of Edmonton.	Good poultry sanitation; rotate ranges, keep birds away from their droppings; use clean, disinfected laying houses; good roosts and dropping board construction. Restock with day-old chicks only from approved hatchery; drugs available for treatment.
Pullorum	A generalized bacterial infection killing mostly baby chicks and poults, transmitted by direct contact through the eggs.	A continent-wide blood testing program has greatly reduced the incidence. Restock with only day-old chicks from an approved hatchery where all eggs are set from pullorum and Fowl Typhoid tested birds; drugs available for treatment.

SOME REPORTABLE DISEASES IN ALBERTA

Disease	Species Affected, Cause and Symptoms
Hog Cholera	A virus infection that causes a high mortality in hogs; high fever, off feed, disinclined to move, weakness and diarrhea.
Anthrax	A bacterial infection of horses and cattle; swelling of throat or other parts; temperature rise; blood from nose or mouth, usually quick death.
Mange (scab)	A parasite (mite) infestation of horses, cattle and sheep; excessive itchiness, loss of hair or wool.
Scrapie	A nervous disease of sheep and goats with great itchiness; restlessness, excitable, grinding of the teeth; scratching of itchy spots causes tremor or smacking of the lips; finally animal weakens and dies.
Others:—	Foot and Mouth Disease, Rinderpest, Rabies, Fowl Typhoid, Newcastle Disease, Vesicular Exanthema of Swine and other diseases that may be introduced from foreign countries.
Action:—	If any of the above diseases are suspected, contact nearest sub-district office, district office at 403 Public Building, Calgary, or a veterinary practitioner who is required by law to report to Federal authorities.

POISONINGS

A considerable number of cattle, swine and other livestock are lost each year through poisoning. Many such losses can be avoided if potential dangers are recognized and known harmful substances properly handled. In most cases, healthy animals will sicken or die suddenly with an observable period of illness. Diagnosis is established by the demonstration of the poison in the stomach and organs of the animals. A veterinarian should perform the post mortem in order that specific changes may be noted and proper material is collected. This is most important if there is a possibility of damage claims. Some commonly encountered poisons are listed below.

(a) Plants — This poisoning occurs usually when normal forage is in short supply;
— water hemlock, larkspur, algae (water scum) death camas, loco weed, nitrate poisoning (oat hay).

(b) Chemicals — Death-dealing chemicals include lead, arsenic, sodium chlorate, mercury, nitrates. Agricultural chemicals, including insect sprays, some weed sprays, some wood preservatives, and livestock sprays are dangerous if used carelessly.

(c) Waters Chemically unsuitable waters do not often cause death but they will seriously affect the health of animals. The presence of the following substances in amounts indicated and greater are unsuitable:—

Sodium chloride (salt)	50 grains per gal.
Sodium sulfate (Glauber's salts)	100 grains per gal.
Magnesium sulfate (epsom salts)	100 grains per gal.
Sodium carbonate (soda)	100 grains per gal.
Iron	0.3 parts per million
Nitrates	5.0 parts per million

Water supplies can be checked by submitting a sample in a clean sealer to the veterinary laboratory. There is no charge.

PREVENTING LIVESTOCK LOSSES

Practical points of livestock production which are important in preventing disease losses.

Swine

1. Care in the purchase of breeding stock. Buy only from disease-free premises.
2. Follow accepted practices in feeding and management of pregnant sows.
3. Provide farrowing quarters that avoid drafts and dampness in the colder seasons of the year and which can be readily cleaned and disinfected.

4. Iron treatment to prevent anemia as outlined in a previous section.
5. Castrate male pigs while still on the sow.
6. Creep feed and starter rations are important.
7. Follow a routine worming program, combined with good sanitation and pasture rotation.
8. Inoculate routinely with erysipelas bacterin at eight weeks of age.
9. Never feed meat scraps, table scraps, garbage or offal to swine. Such products may carry bacteria and virus that are cause of some serious swine diseases. It is illegal to feed collected garbage or offal without a permit from the Veterinary Director General, Confederation Building, Ottawa.

Dairy Cattle

1. Good management practices for the feeding and housing of calves.
2. Dehorn and castrate as early as possible.
3. Calfhood vaccination for control of brucellosis.
4. Follow a program designed to prevent and control mastitis. Good sanitary milking practices, udder care, the routine use of a strip cup, and a sponsored mastitis control program if needed.
5. Vaccination of calves and yearlings with blackleg-malignant edema bacterin before pasture season.

Beef Cattle

1. The supplementation of diet of pregnant cows with vitamin A and mineral to ensure a healthy calf.
2. Vaccination of calves with a blackleg-malignant edema bacterin. Yearlings should be revaccinated.
3. Make certain cattle in feedlots have been properly vaccinated for blackleg and malignant edema.
4. Calfhood vaccination for brucellosis control.
5. A Pasteurella (pneumonia) bacterin can be used in the fall as additional protection against pneumonia.
6. Mineral supplements for pasture cattle will eliminate some of the commonly-occuring sterility problems.

Sheep

1. Adequate feeding of pregnant ewes with vitamin supplements to ensure healthy lambs.
2. Follow a routine worming program, with administration of phenothiazine or thiabendazole in January, early summer and fall.
3. Inoculate feeder lambs with Clostridium perfringens Type D bacterin.

Poultry

Do :

1. Purchase day-old chicks or poults from an approved hatchery.
2. Brood chicks or poults in clean, disinfected brooder house.
3. Feed chicks only a good commercial or recommended chick starter. Feed poults only a good commercial or recommended turkey starter. No other feed should be necessary until the birds are six to eight weeks old, then give growing mash (see feeding).
4. Put birds onto good green range when ready. Fresh range should be used each year (see Range Rotation).
   Range should be well away from barn yard.
5. In the fall, bring hens into clean, disinfected laying house.
6. Keep litter in hen house dry.
7. Use proper roosts and screen off droppings under roosts.
8. Use sanitary feed and water troughs—with covers or spinners on top to prevent droppings getting into feed and water.
9. Raise feed and water troughs at least one foot off the floor.
10. Bury or burn all dead birds.
11. Fill in all low or damp spots on the range or fence them off.

12. Control lice—with malathion. Malathion can be applied to birds but not lindane or nicotine sulphate which should be painted on roost.
13. Control mites — with malathion.
14. Sell off the old flock in the spring, after peak egg production is over — and clean and disinfect the hen house.
15. If you have birds that die — find out why. See your veterinarian.
16. Check on your management. See your poultry inspector or district agriculturist.

Don't:

1. Don't run chickens and turkeys together. It's only a matter of time before you run into trouble.
2. Don't run poultry and pigs together — keep them all separate as they can get disease from one another, especially tuberculosis.
3. Don't throw dead birds to the pigs.
4. Don't throw dead birds on manure piles — bury them.
5. Don't let poultry get onto the manure piles.
6. Don't overcrowd birds. Allow four square feet of space for each hen.
7. Don't let poultry run all over the barn yard. Have a place for them and keep them there.
8. Don't fertilize poultry or hog ranges with poultry manure.
9. Don't let visitors into your poultry pens and yards unless they wear clean rubber boots.
10. Don't feed grain on the floor or ground.
11. Don't bring dirty crates or equipment into your farm.
12. Don't go into a neighbor's poultry pen—especially if he has sick birds. If you must—disinfect your shoes or boots before you go to your own flock.
13. Don't feed birds the insides of dressed chickens or turkeys.

REFERENCES

University of Alberta

	Bulletin No.	Agdex No.
Rabies	89	663-8
Cattle		
Bang's Disease	84	663-4
Blackleg and Allied Diseases	136	663-2
Bloat in Cattle and Sheep	112	663-1
Mastitis Prevention and Control	26	667-1
Shipping Fever of Cattle	88	663-3
Vibriosis	138	663-5
Swine		
Diseases of Suckling Pigs	14	660
Infectious Rhinitis	12	663-6
Swine Erysipelas	116	663-7
Swine Parasites	13	660-1
Poultry		
Coccidiosis	31	669-3
External Parasites of Poultry	29	653-9
Internal Parasites of Poultry	30	654
Respiratory Diseases of Poultry	32	669-4
Tuberculosis of Poultry	28	669-2
Diseases of Poultry #45	—	669-6

INSECTICIDES FOR LIVESTOCK INSECTS

Modern insecticides, properly used, will control most insects attacking livestock. Insect control will increase weight gains, grade of carcass, milk flow, and health of animals generally. It is essential for profitable livestock production in small farm herds as well as large ranch herds.

Satisfactory control of most livestock pests can be achieved economically in small herds by judicious choice of equipment and method to suit particular types of farm operators. Control of houseflies and warble flies is most effective with community action.

Insecticides can be applied as sprays, washes, dusts and backline applications.

For spraying cattle with long hair coat the sprayers must:

1. Be capable of maintaining pressure up to 500 pounds per square inch, and be able to deliver at least four gallons per minute.

2. Be equipped with a mechanical agitator in the tank, and adequate strainer between the tank and the pump, and suitable drain cocks for draining pump and tank.

High pressures are necessary for livestock sprays to penetrate the hair. The chemical must reach the skin to control warbles and lice and to penetrate the warbles with rotenone. Universal type sprayers are most suitable and are available at reasonable cost.

When using wettable powders in spray machines, special precautions should be taken to see that the pump is thoroughly washed after each use. Such materials should never be left in the tanks over night.

Single nozzle adjustable spray guns are most satisfactory for treating warble grubs in the backs of cattle. Triple nozzle spray guns are suitable for fly control on animals and around barns and other buildings and for mosquito control on farmsteads. Fan-type guns delivering sprays with high force of impact may be used for warbles, lice and other livestock insect control work.

Self applicators (back rubbers) for applying chemicals to livestock are satisfactory for control of horn flies. They are of doubtful value in the control of other biting flies (horse flies, deer flies, mosquitoes, black flies, etc.), and lice. They have no value in the control of warbles.

Suitable applicators may be cheaply made with materials available on any farm. Several strands of barbed wire may be loosely twisted together and wrapped with old sacking, until a roll about six inches in diameter has been completed. This is then tied tightly every four to six inches with heavy cord. This roll may be attached to two posts placed a rod apart. It should be fastened four to five feet above the ground at the posts, and allowed to sag within a foot of the ground in the centre. It should be soaked with a five per cent solution of any pesticide **specifically** labelled for back-rubber use with a suitable solvent. (Solutions suitable for use with applicators can be secured from most chemical companies.)

Solutions containing chlorinated hydrocarbons or any highly residual chemical should not be used in back rubbers accessible to dairy cattle. This applicator will require about one to 1½ gallons of mixture. It will be necessary to moisten it with additional chemical at about weekly intervals. Repairs can be made with additional old sacking and cord. There are many other ways of making such a roll and other methods of attachment to posts. Any method that provides a suitable absorbent roll and allows the animals to treat themselves is satisfactory. The rubber should be located near the water supply or salt block or any area where cattle loaf.

Sanitation — Failure of insecticides to control certain insects, particularly houseflies and stableflies, results from poor sanitation rather than from resistance of pests to chemicals. If manure, litter, and other breeding places are not cleaned up the insects may appear in too large numbers for insecticides to control.

Sanitation Is Essential

Livestock should not be fed on insecticide-treated plants until danger from poison residues is past. The required interval between treating the plants and pasturing or cutting them for feed is given on the labels of the insecticides and should be adhered to in the interest of animal and public health.

If poisoning of livestock by insecticides is suspected, call a veterinarian.

Symptoms are in general similar for most animals. They are nervousness, wild stare, tremor, slobbering, diarrhea, loss of appetite and weight, paralysis and convulsions. Animals in poor condition are more susceptible to poisoning by livestock sprays than those in good condition.

Symptoms of Hydrocarbon Chemical Poisoning
By Dielbrin, Aldrin, Heptachlor, Chlordane, Lindane, BHC, DDT, and Toxaphene.

Symptoms of poisoning may appear in as little as 15 minutes and usually within 24 hours after exposure.

An affected animal will generally first become excitable and more alert to its surroundings. Twitches of various muscles follow, usually beginning at the head and moving back along the body. The twitches may increase in intensity until there are spasms and finally convulsions.

The animal may also assume abnormal attitudes, such as standing with the head between the forelegs and under the body or in a sternal position.

There may be persistent chewing movements. Occasionally the animal attacks any object. Usually there is profuse salivation, dyspnea (difficult breathing), rolling of the eyes, dribbling of urine and bawling. The body temperature often reaches 114 - 116° F.

Some animals show none of these active symptoms. Instead, they become depressed and unaware of their surroundings. Others are alternately depressed and excited.

Severity of symptoms is no index of the likelihood of death or survival. Death may occur in less than an hour — or several weeks after exposure. Most cases run their course within 72 hours.

Symptoms of Organophosphorus Poisoning
By Parathion, Malathion, Trichlorfon, Coumaphos, Ronnel, Ruelene, Ciodrin, Diazinon.

The symptoms of poisoning by these compounds resemble those described above, although there may be some variations from animal to animal. Poisoned animals first show excessive running from the mouth and the eyes, followed by general dullness and depression. The animals shiver and have little inclination to eat or drink. They have difficulty in breathing and walk stiffly with incoordination of the hind legs. Some animals lie down and appear paralytic. In acute cases death occurs from respiratory failure.

Side - Effects

Organophosphate chemicals are mildly toxic to livestock in systemic treatments for animal parasites. Normally there are no direct toxic reactions in livestock following treatment with recommended doses. Side-effects may occur, sometimes as delayed reactions after several days or a few weeks. They are due to idiosyncracies in individual animals in their reaction to normally mild levels of toxicity. They also could be due to the reaction of an animal to sudden release of material from killed parasites in its tissues.

Symptoms caused by dead parasites show an exaggerated reaction to the foreign insect protein. The animal appears to be suffering a type of shock. These symptoms are less likely to appear if treatments are scheduled at the times recommended for effective use. Toxicity due to idiosyncracy is associated with young animals and animals on high feeding levels.

INSECTICIDES FOR LIVESTOCK INSECTS

Insect	Nature of Damage	Control
Lice (of cattle)	Biting lice feed on skin surface and irritate animals. Sucking "blue" lice, common in winter, suck blood, reduce milk yields and weight gains, cause rash, severe irritation and anemia. Lousy animals get thin and may die. Lice begin to show up in the fall as dark patches where the hair is thin, particularly along the underline. A lousy animal has greasy patches of hair and an odor of stale blood. Eventually the hair is rubbed off in patches.	Wash, dust or spray with malathion; coumaphos, ronnel, lindane, DDT, Ruelene, chlordane, toxaphene, methoxychlor or rotenone according to the instructions on the labels of the insecticides. Chemicals must reach the skin. When spraying the operator should hold the gun within 12 inches of the animal's body. Fall treatment is preferable. Where cold weather treatment is required, use a dust.
Cattle Warbles (Heel flies or gadflies)	Warble flies worry and frighten animals when laying eggs on legs and lower part of body. This causes gadding which reduces milk yields and weight gains. Grubs in animals reduce milk and meat yields and carcass grades, and cause unthriftiness and injury to hides. Contrary to general belief, warble flies cannot bite or sting.	Community action is recommended but single-farm control can be effective. Cattle grubs can be killed before they form warbles in the back by treating the animals with systemic insecticides—the compounds that are absorbed by cattle and passed on to the parasites. Treat with coumaphos, Ruelene, trichlorfon, or ronnel according to the instructions on label. For cows in milk use rotenone powder (warble powder). These insecticides will control cattle lice also. TIME: Only one treatment in the fall is necessary with systemic insecticides. Read the label for the timing of treatment. METHOD: Coumaphos, Ruelene and trichlorfon are used as sprays or pour on applications, and ronnel is given in feed. Apply according to the labeled instructions. If sprayed, these chemicals must reach the skin. While using rotenone for warbles in the backs of cows in milk or other animals, scrub, wash or rub the powder into warble holes. Spray one-half gal. per head of 0.05 per cent rotenone under 400 - 500 lbs. pressure with a single nozzle gun fitted with a 5/64-in. disk.
Face flies	Face flies rest on faces of cattle and feed on secretions from eyes and muzzle. They	Dichlorvos may be applied with a brush or by spraying the forehead of each animal at the rate

Insect	Nature of Damage	Control
	have been incriminated in the spread of infectious diseases of cattle.	of 1/5 oz. per head of a mixture of 1 tsp. 20 EC dichlorvos + 3 oz. water + 3 oz. corn syrup. Insecticidal dusts may be used. These may be applied by a hand duster or by bunt bags consisting of muslin lined jute bags containing the dust suspended across lanes where the animals must pass.
Houseflies	The house fly carries and spreads diseases and parasitic worms of man and animals. The maggots are found in manure, garbage, and other decaying materials.	Sanitation is essential. Clean-up breeding places in barns, feedlots, garbage, and privies. Treat privies with chloride of lime. Spray manure piles with malathion. Spray interior and exterior of barns, chicken houses, privies, etc., with chlordane, Ciodrin, diazinon, dichlorvos (Vapona 20), dimethoate, dimetilan, malathion, methoxychlor, ronnel, or trichlorfon. Household residual sprays or pyrenone space sprays are available. Poison baits may be used. If a power sprayer is used limit the disc opening to 4/64 inches.
Hornflies	Irritation and loss of blood caused by small, dark grey, biting flies clustering behind the shoulders of cattle. Sometimes attack sheep and horses. Mainly July-August.	Treatment may be with carbaryl, Ciodrin (spray or backrubber), dichlorvos, DDT, lindane, malthion (spray or 4 per cent dust), methoxychlor, ronnel (spray or backrubber), or toxaphene. Do not use DDT on dairy cows, or on any animals within one month of slaughter. Power sprayers or backrubbers may be used for range animals.
Stable flies	Painful bites, loss of blood. May transmit disease.	Eliminate breeding places; spread manure and wet litter, plow under stack bottoms. Spray barn interior with residual insecticide—(see house flies) spray entire animal.
Black flies	Feeding by small humpbacked, greyish flies on thinly-haired parts of animals, particularly cows and bulls, causes loss of blood, soreness, swellings, serious illness or death within a few hours of first mass attack late in May or in June. Milk production may be reduced. Swarms of killing species come mainly from rocky rapids of fast flowing rivers. Less dangerous, but highly troublesome species, emerge from other rivers.	Watch carefully for dangerous swarms of these flies particularly in late May and in June; as soon as any appear stable valuable animals, particularly bulls. Small swarms may occur throughout the summer. Use smudges to protect animals that cannot be stabled. Serious damage is most common within 50 miles of fast flowing rivers. Some relief may be obtained by spraying animals as for mosquitoes.

INSECTICIDES FOR LIVESTOCK INSECTS

Insect	Nature of Damage	Control
Ticks (not to be confused with sheep keds)	Ticks fasten themselves to most animals running on infested scrub-covered pastures and ranges, particularly in May and June; suck blood causing weakness. May transmit diseases such as Rocky Mountain spotted fever and tularaemia.	Destroy rodents on ranges. Keep animals off infested areas. Spray infested animals with toxaphene or lindane. Individual ticks may be picked off by hand. Mostly confined to the south of the province.
Lice (of sheep, goats, and hogs)	Irritation, rash, loss of hair or wool.	Spray at least at 250 lb. pressure with 5/100 per cent lindane, ½ per cent toxaphene, malathion, methoxychlor, coumaphos, or ronnel in a crowding pen. Treatment and precautions as for cattle lice. In cold weather dust by hand with commercial dusts. Rotenone is poisonous to hogs.
Lice (of poultry)	Chickens appear dopey and listless; egg production falls off.	Clean out poultry house, then spray roosts, floor and nests with 0.5 per cent lindane or malathion, 40 per cent nicotine sulphate or 2 per cent ronnel. Then dust birds by hand with 4 per cent malathion at 1 lb./100 birds or with commercial rotenone dust.
Mites (of poultry)	Scaly leg mite feeds on blood. In time may cripple bird.	Soak legs in soapy water to loosen scales, then paint legs and feet with 1/10 per cent lindane, or apply crude oil or equal parts kerosene and raw linseed oil. Spray roosts as for lice.
	Roost mites suck blood at night; on roosts and walls in daylight. Northern fowl mites remain on birds and congregate at the vent and neck where they suck blood.	Spray roosts and nests as for lice. Dust birds with 5 per cent carbaryl, or 4 per cent malathion dust at 1 lb./100 birds.
Mosquitoes	Worry and loss of blood. May transmit disease. Mosquitoes breed mainly in temporary pools, in weedy roadside ditches, permanent sloughs, and pasture depressions.	Drain breeding places in entire community, or kill larvae soon after pools form in the spring with a film of oil, with or without DDT added (1/10 to ¼ lb. per acre). To kill adults use a residual spray of DDT wettable powder on vegetation and buildings to a height of 10 feet. Pyrenone livestock sprays, smudges, or commercial fly repellents will give some relief.
Horse Bots	Flies annoy animals while laying eggs on lips, throat, and legs. Young grubs enter the mouth and grow there for a month; then are swallowed and cling to wall of stomach	Provide darkened shelters for pastured animals. Use nose muzzle and under-jaw protection. Before Dec. 15, mix 2/5 oz. (dry weight) trichlorfon concentrate in feed per 1,000

Insect	Nature of Damage	Control
	and intestine, sometimes causing death. These flies cannot bite or sting.	lbs. of animal or provide treatment by veterinarian with carbon bisulphide capsules.
Horse flies (Deer flies, Bulldogs)	Painful bites, loss of blood, unrest and gadding in cattle. May transmit disease.	Provide darkened shelters for animals. Use pyrenone livestock sprays. Fly nets or coverings may help.
Sheep Keds (miscalled sheep ticks)	Brownish, flattened, tick-like insects about ¼ inch long. Pollute fleece and reduce vitality due to loss of blood and irritation.	A week after shearing thoroughly wet all sheep by spraying at 250 - 400 p.s.i. in a crowding pen using 5/100 per cent lindane or ½ per cent toxaphene, malathion or methoxychlor. Coumaphos or ronnel may be sprayed at 0.25 per cent concentration or 1 per cent rotenone used as a dust. In cold weather dust by hand with commercial rotenone dust.
Mange and Scab Mites	Attack horses, cattle, swine and sheep. Irritation causes animals to rub and scratch; scabs form in advanced stages, and there is loss of hair or wool.	When on horses, cattle, or sheep, must be reported to the Health of Animals Branch immediately. When on hogs, scrub, or spray at 350 - 400 lbs. pressure, premises and animals with lindane using one lb. 50 per cent wettable powder in 100 gals. of water. Two scrubbings or sprayings are necessary at 10 - 12 day intervals. Clean up infested premises.
Fleas (of animals and birds)	May carry disease and tapeworms. Adults small, dark, shiny, jumping insects. Larvae up to ¼ inch long; in bedding.	Thoroughly clean floors, carpets, and especially the sleeping quarters of dogs and cats. Then spray or dust quarters and dust animals with methoxychlor, rotenone, or malathion. Rid dogs and cats of fleas with dusts containing rotenone, methoxychlor, pyrethrum, or carbaryl.

BEEKEEPING

Beekeeping in Alberta falls into three categories, commercial, sideline and hobby. Commercial beekeepers whose major income is derived from bees operate at least 500 colonies. Sideline beekeepers supplement their regular income with from 40 to 200 colonies. Hobbyists keep from one to 25.

An average production of 120 to 140 pounds of honey per colony may be expected in most areas with good management. The price of honey has provided satisfactory investment returns.

Everyone keeping bees is required by law to register with the Apiary Branch, Alberta Department of Agriculture, the number of colonies kept and the legal land description of where they are kept. There is no registration fee, but annual registration is required.

Before attempting beekeeping, consideration should be given to a few pertinent factors. A person should not be unduly affected by bee stings. Time should be available at the critical periods of management. A study of bee behavior, management and disease control should be made.

Beginners should start with at least two packages of bees. Any beginner considering beekeeping as a commercial enterprise should spend at least one season with an established beekeeper. Observations can be made and losses due to mismanagement avoided. Nectar producing plants of the area that the prospective beekeeper expects to establish in can be assessed to determine the optimum number of colonies to be operated.

The importance of visiting the apiary branch, district agriculturalist, the experimental farm at Beaverlodge, beekeepers and local beekeeping associations to get information cannot be over-emphasized.

Equipment — A sanitary, bee and fly-proof building, preferably with a concrete floor must be available for super storage and honey extraction. For every colony a hive cover, bottom board and five supers with nine frames each are required for satisfactory operation. A bee veil, smoker, hive tool, gloves and coveralls are necessary personal items.

The extracting equipment required depends upon the number of colonies operated and can best be recommended by the Apiary Branch.

To prevent the spread of bee diseases, specifically American Foulbrood, all used bee equipment must be inspected and a permit issued by the Apiary Branch before the equipment can be bought or sold. When purchasing used bee equipment, it is advisable to demand an inspection certificate.

Management — Almost 95 per cent of bee colonies in Alberta are from package bees imported from California. Although bees can be wintered successfully with adequate stories, good laying queens and proper care, the number of colonies wintered is small.

The Italian strain of bees is most popular, however, hybrids and Caucasion bees are preferred by some. Two-pound packages with a queen generally are ordered in February or early March. They may be ordered from a reputable supplier or directly from the package bee shipper.

Packages should arrive during April. Each brood chamber should have 40 pounds of honey or the equivalent in sugar syrup. It also should have three frames of pollen. The apiary should be on high ground. It is desirable to have a shelter to the north and west of the apiary.

Dandelion and willow provide nectar and pollen for spring build-up. Sweet clover, alsike and red clovers, alfalfa, fireweed and rape are the main nectar secreting plants in Alberta. At least one acre of these plants per colony within a 1½ mile radius of the apiary is necessary for a good honey flow.

Colonies should be examined within one week after installation for acceptance of queens and to replace queens not accepted. Examinations every two weeks up to mid-June are necessary. After that time to mid-July or later, colonies should be examined at least every 10 days for swarm control. Supers, the boxes that hold the honey combs, may be emptied of their honey when the combs are two-thirds capped.

Colonies should be killed when the honey flow ceases, usually about the end of August. This is because an unnecessary consumption of stores will reduce the honey surplus. The danger of granulation of honey in the comb, especially near rape fields, is more acute in September than in August.

If honey granulates or hardens in the comb it cannot be extracted.

Pollination — The value of bees as pollinators of legume seed crops far exceeds the value of honey produced. One colony per one to two acres is recommended for clovers. Honeybees do not significantly increase the seed yields of alfalfa in Alberta. However, alfalfa is visited quite freely by the bees for nectar. Honeybees, on the other hand, have been found to increase seed yields from Polish-type rape as much as 200 pounds per acre.

Legume seed growers should make arrangements with commercial beekeepers to provide bees to pollinate crops rather than attempt beekeeping themselves. Operating a large number of colonies conflicts with major farm operations.

Diseases — Disease control is of utmost importance. It is the responsibility of every beekeeper. American Foulbrood disease is considered the most serious. It kills the unhatched brood resulting in serious reduction of hive populations and unprofitable honey production.

American Foulbrood spreads from one colony to another and even one apiary to another if not controlled. European Foulbrood is a less serious brood disease, but it too can reduce honey production.

Sac-brood, caused by a filterable virus, is often present in wintered colonies and less often in package bee colonies. Nosema, an adult bee disease, is present in most colonies in varying amounts. It is worst in cool, damp seasons. Any suspicion of disease in an apiary should be reported to the Apiary Branch, Alberta Department of Agriculture, Edmonton, or to the nearest District Agriculturalist.

Marketing — The Apiary Branch prepares bulletins on marketing conditions for honey regularly. These are sent out to all registered beekeepers.

Most commercial operators market their honey in bulk. Honey sold directly from producer to consumer does not come under marketing legislation. Honey sold through retail outlets must have the name and the address of the packer, the grade and the class of honey. This information is stamped or printed on the main label of the container.

Grade is determined mainly by the water content and freedom from foreign material. Class is determined by color. White, golden and amber, and dark are the classes. Grades are numbers one, two and three.

Samples of about one ounce of honey may be forwarded to the Apiary Branch for grade and class determination. For complete regulations, get a copy of the honey grading regulations from the Alberta Department of Agriculture at Edmonton.

REFERENCES

	Bulletin No.	Agdex No.
Canada Department of Agriculture		
Package Bees For Profit	1227	——

Hives and the Honeybee, Dadant, Hamilton, Illinois.

"ABC and XYZ of Beeculture", A. I. Root, Medina, Ohio.

FUR FARMING

Fur farming in Alberta consists mainly of mink farmers in full-time operation and chinchilla raisers who are more on a hobby basis. However, there are signs that some chinchilla raisers are gearing for a commercial operation.

Location of the Mink Ranch

Mink farms should have access to transportation facilities and should be close to cold storage, feed supplies, a supply of clean water, and a source of electric power. In Alberta, about two-thirds of the licenced mink farmers are located around Lac La Biche and Lesser Slave Lake which both produce a bountiful amount of raw fish suitable for mink feed.

Housing Mink

Modern technology of raising mink is in sheds. With the high color shades raised today, it is the only satisfactory way of rearing mink. Sheds and pens may vary according to individual preference and local weather conditions. The construction should provide sanitary, warm, dry nests and good ventilation, with ample ground drainage facilities. Sanitation is most important, both to the production of a good pelt and the welfare of the community where the mink are raised.

Chinchilla breeders generally use the basement of their home or the family garage to carry out their current fur farming enterprise.

Equipment

A well-equipped feed house, pelting shed and refrigerator, all located close to the mink yard, are all essential buildings on the mink farm. Automatic watering systems, feed carts, feed grinders and mixers, power equipment are all required to cut down the labor force and labor costs.

Disease

Three major diseases plague the mink industry, namely, distemper, virus enteritis and botulism. These diseases can be controlled and could be practically eliminated with a disease control program of constant and regular vaccination. Many other problems pertaining to mink and chinchilla are diagnosed at the veterinary laboratory of the Alberta Department of Agriculture, Edmonton, each year. Corrective measures are recommended.

Associations and Marketing

The fur breeders are well organized both locally and nationally. The mink breeders deduct 1½ per cent from the sale of their pelts at the auction house level. This is then returned to Canada Mink Breeders Association to advertise and promote mink. This is one of the first primary producers to organize such a program. They have been able to maintain themselves in a satisfactory way, without any subsidies or outside help of any kind.

References and Bulletins

Bulletins and booklets are available through the Fur Farm Branch on the raising of mink, chinchilla, nutria and rabbits. Seasonal and local bulletins on changing technologies are being distributed to the fur farming industry as required. Annual statistics compiled by the Fur Farm Branch show that annual mink pelt returns to the fur farmer of the province average from three to 3¼ million dollars each season. Mink, then, is an important part of the Alberta agriculture industry.

REFERENCES

	Bulletin No.	Agdex No.
Canada Department of Agriculture		
Mink Production, Management and Nutrition	—	1043/65
Raising Chinchilla	1177	——
Raising Rabbits	—	1200/64
Ontario Department of Agriculture		
Control of Virus Enteritis	Circular 351	——

Other Sources

Practical Methods of Mink Ranching, by Dr. E. Rendle Bowness.
Master Feeds, 417 Queen's Quay West, Toronto, Canada.
The Chinchilla Story, The National Chinchilla Breeders of Canada, Carleton Place, Ontario.

AGRICULTURAL ENGINEERING

FARM MACHINERY

Farm machinery should be selected and purchased on the basis of a definite need. Factors such as the potential saving in labour, capacity in terms of the need on the farm, and the availability of service should be considered in relation to price. Over-capitalization in machinery and equipment can be a serious fault in management.

Field capacity can be estimated as follows:

$$\frac{\text{Width (inches X miles/hr.}}{100} = \text{Acres/hour}$$

TILLAGE MACHINERY

The primary objective of tillage for dry land farming are moisture conservation, weed control and seed bed preparation. Secondary objectives include the control of erosion (both wind and water), insect control, and disease control. These can normally be obtained by selection of tillage equipment to accomplish the primary objectives. Land shaping, levelling and ditching are important operations in the irrigated areas.

Tillage to a depth of about four inches is normally recommended. It is rarely of advantage to till deep in normal soils. Depth is measured by laying a straight edge on the unworked surface and measuring to the bottom of cut. The depth of operation is usually established by the first operation, with subsequent operations being the same depth or less.

Plows — The moldboard plow is still widely used for breaking hayland and to a lesser extent in stubble plowing. It is important to use a moldboard suitable for the soil and type of plowing.

Disc Plows — These plows are used in heavy clay soils where the moldboard will not scour properly. The discs are inclined at an angle to assist penetration. Disc plows leave the soil somewhat rougher than the moldboard plow.

Disc Equipment — This includes disc harrows, discers, and one-way discs and generally all implements on which the discs are mounted vertically, usually on a common shaft. The principal difference between disc implements is in size and spacing of discs. Increased penetration may be achieved by one or more of the following: adding weight, changing to narrower cut, using deep concavity blades or sharpening the blades.

Machines with wide disc spacing must be operated deeper to obtain a clean cut. Deeper penetration or narrower cut means higher power requirements, but gives a cleaner cut with any given machine. Proper hitching and correct adjustments are necessary.

Disc type machines have a tendency to pulverize the soil and should be used with care where soil erosion is a problem. The maximum speed recommended is four miles per hour so the proper size machine should be selected to load the tractor at this speed.

Disc breakage in stony ground may be reduced by one or more of the following methods: decreased speed, wider angle of cut, less weight or removal of stones.

Heavy Duty Disc — This disc may be offset, single acting or tandem, equipped with 26 to 30 inch discs that may be plain or notched. These machines are of heavy construction and with added weight may be used for breaking light brush or grassland. Power requirements are high.

Cultivators — Cultivators are the most useful of all tillage implements for soil conservation and erosion control. Included are duck foot, heavy duty, tool bar, and blade cultivators. Cultivators use shovels or sweeps that cut off weeds below the surface with minimum disturbance to the soil and surface trash. Vertical hitch adjustment should be set so that all shovels or sweeps operate at the same depth.

Heavy Duty and Tool Bar Cultivators — These cultivators have heavy rigid frames and the shanks are constructed of heavy spring steel with spring cushion but no trip mechanism. The shanks are arranged in two or three rows and are usually adjustable to give different spacing. A 12 inch spacing with 14 or 16 inch sweeps is customary. Chisel points also are available. The heavy duty cultivator has sufficient clearance for most trash conditions.

Blade cultivators consist of one or more wide sweeps on a rugged frame that will clear any trash condition. The blade is wide and steep, depending on a tumbling action to shake soil from the roots. Speeds over four miles per hour are recommended. This machine is not satisfactory under wet soil conditions.

Subsoilers — Subsoilers have not found a general appreciation in Alberta.

Harrows — Harrows are available in types including stiff tooth, lever, spring tooth and oscillating. Harrows are used for starting weed growth, killing small weeds and packing after other operations. Care must be exercised where soil erosion is a problem as harrows have a pulverizing action. Oscillating harrows will work in very heavy trash and are effective for spreading dry straw.

Row-Crop Cultivators — Row-crop cultivators in single or multiple row units are best used on tractors designed with adequate clearance and wheel-tread adjustment to meet the needs of the crop. A complete range of cultivator attachments should be available. These are: discs, knives, duck-feet, shields, and in irrigated areas, furrowing shovels. Hillers are available for potatoes. The drilling of straight, evenly spaced rows and careful slow-speed operation of the cultivator provide quality tillage without damage to the crop. The width of the planter and the width of the cultivator should be balanced so that the cultivator is not required to span the guess-row.

Row-Crop Thinners — These row-crop thinners are primarily used for the mechanical thinning of sugar beets. Down-the-row thinners are available in either tractor-mounted or trailer types. The tractor-mounted type is more easily held on the row. Mechanical thinners, equipped with spring-type heads, are useful for pre-thinning, weeding and crust-breaking operations when equipped with the proper thinner heads. They are used for either partial or complete thinning of the crop. Successful use of the thinner is dependent upon a satisfactory initial stand of beet heads based on stand counts taken in the field before and after each operation, and careful operation of the machine.

SEEDING AND PLANTING EQUIPMENT

The selection of the proper type of seeder is governed by the crop to be seeded, soil, climate and type of farming. In areas where moisture conditions near the soil surface are favourable to germination, the double disc furrow opener mounted on either a low wheel or high wheel carriage in satisfactory further packing is not essential to obtain a good stand. If moist soil is two to three inches from the surface, a press wheel attachment is used on a one-way disc or discer. It is essential to use a packer to obtain good soil to seed contact.

Double Disc Furrow Openers — Double disc furrow openers are suited to seeding a wide variety of crops, including cereals, oilseed crops and grasses where soil moisture is three inches or less from the surface. Double disc openers give uneven seed placement when used on very heavy trash.

Semi-Deep Furrow Openers — Semi-deep furrow openers, (hoe or shovel) with eight to 10-inch spacing and mounted in gangs on a press wheel carriage are suitable for seeding through moderate amounts of trash. The semi-deep furrow seeding principle designed into these drills permits their use on a dry or semi-dry seedbed where moist soil exists at a depth of about four inches below the surface. These seeders are not suitable for use when the surface is wet.

Deep-Furrow Openers — Deep-furrow openers, (shovel type) are used primarily for seeding of fall sown crops in dry areas. Furrow openers spaced 12 to 14 inches apart can be operated to a depth of four to five inches with a resulting cover of two or three inches of soil over the seed. Deep-furrow and semi-deep furrow drills should not be pulled at high speed as this throws an excessive covering of soil over the seed in the furrows.

One-way Seeders — The use of the seeder box attachment on the one-way disc and discer for stubbling-in cereal grain provides results equal to that of other methods of seeding where annuals constitute the major weed problem. On medium to heavy textured soils, one-way seeders perform equally with other seeders for seeding summerfallow. Thorough packing is essential to obtain a good stand. Proper seed spout adjustment, the use of a medium to narrow width of cut and careful depth adjustment are also important.

Combination Grain and Fertilizer Drills — Grain-fertilizer drills are available or separate fertilizer attachments are available for most types of seeders. Fertilizer distribtuing mechanisms, whether on the drill or employed as a separate broadcast spreader, should be carefully cleaned after use as fertilizer absorbs moisture from the air and then corrodes the moving parts of the mechanism. Use of a light oil on these parts after use is recommended. Fertilizer should not be distributed through the seed cups of a drill because it is abrasive.

Seeders for Grass and Small Seeds — Grass and small seed seeders are available as attachments for most drills and will distribute the seed through the seed spout of the drill or drop it on the surface behind the furrow openers. These attachments are designed primarily for metering fine seeds such as clover and alfalfa. They will not distribute grass seeds such as brome satisfactorily.

Slow speed drive attachments are available for some drills to reduce the speed of the feed shaft. This increases the metering accuracy for small seeds such as rape, mustard and clover. Special seeder boxes mounted on a double gang packer will handle all types of seed. These seeders broadcast the seed behind the front packer gang and it is covered with a half inch or less of soil by the second gang. The seed bed must be firm and uniform with moisture at the surface for uniform germination with this seeder. These units pulverize the soil surface and the threat of wind erosion must be considered.

Broadcast Spreaders — Broadcast spreaders of the cyclone type are designed for the surface application of fertilizer and other materials. They should be calibrated to deliver the required amount of material.

Row-Crop Planters — Row-crop planters are designed to handle a wide variety of crops grown in rows. The proper seed plate must be used for each crop. The precision drill for sugar beets should be pulled at a slow speed, about two m.p.h. The drill should be kept in good mechanical condition. High speed decreases the rate of seeding and disturbs the accuracy of seed placement. Rows should be as straight as possible to make following cultivation easy. Fertilizer attachments should be carefully calibrated. The shoe or runner-type openers should be sharpened to maintain their original shape.

HARVESTING MACHINERY

Swathers — Swathers either pull type or self-propelled, should lay a closely knit windrow of grain, which is supported on top of the stubble. For best support the stubble should be about one-third the height of the original grain, but not over 10 inches high. The canvas and reel speed should be equal to or slightly greater than the forward speed of the machine.

Combine, Harvester — Combines will handle all types of grain crops, grass seed, clover and rape seed, provided the machine is adjusted correctly and special equipment is used where necessary.

Harvesting Machinery Attachments — The pick-up reel is useful in badly lodged crops. Grain saving guards or pick-up fingers are useful for saving tangled and lodged grain but will not work effectively if the crop is weedy. Pick-up reels and pick-up fingers should not be used together. Wind reels may be used to reduce shelling losses.

Recleaners are useful for removing weed seeds and cracked grain.

Straw Cutters — Straw cutters are available for most combines and will shred and spread the straw. Three to eight horsepower is required to operate these attachments. Straw bunchers provide a method of collecting combine straw for feed or bedding.

Straw binding equipment ties loose rectangular bales and is mounted on the rear of the combine.

Sugar-Beet Harvesters — Single-row units, tractor-mounted and employing self-unloading trailer-carts, have a capacity of three to five acres per day. Daily capacity is strongly influenced by efficient use of hauling facilities and by harvesting conditions. Single-row machines have adequate capacity for 40 to 60 acres per season under most conditions. Growers producing less than 20 acres of beets per year should consider either joint ownership or custom operation to justify the expense.

Multi-row harvesters generally require two operations to top and lift beets. Economical ownership requires seasonal use on 60 acres or more.

Ground toppers and within-machine toppers should be operated by moderate speeds of three to four miles per hour. High-speed operation can result in inefficient topping, poor root recovery, and excessive breakage of tap roots as a result of failure to drive on the row. High quality work requires careful adjustment of the machine.

Top-saving devices are available on most machines where tops can be utilized for feed. Care should be taken to preserve quality. A side-delivery rake can be used to shift the windrows of tops to avoid trampling by trucks and the harvester.

HAY AND SILAGE MACHINERY

Forage crops may be harvested as dry hay or silage. Green oats or barley are frequently harvested as silage. The equipment and system used will depend on the size of operation, method of storage, climatic conditions and available labor.

Mowers — Power take-off mowers are available in side mounted, drawbar mounted, and trailing models with hydraulic or mechanical lift. The important adjustments are pitman and cutter bar alignment, and knife registration. The knife bar end of the pitman should have a lead of ⅛ to ¼ inch. The outer end of the cutter bar should lead the inner end ⅛ inch for each one foot of cut. The knife sections should centre on (register) a guard at each end of the stroke.

Swathers — Grain swathers may be used for cutting and windrowing some hay crops, but may require special attachments. Many machinery companies manufacture self-propelled swathers engineered for hay windrowing. These machines are available with hay conditioners permitting fast drying of windrows.

Rakes — Dump rakes may be used where hay is to be handled by sweep or hand. Where balers and forage harvesters are used, it is necessary to use a side delivery rake or swather to form an even, continuous windrow. Several types of rakes are available in power-take-off or ground drive. P.T.O. drive limits the selection of tractor gears. Ground drive may be operated in any gear and at any speed suitable to the conditions.

Sweep Rakes and Stackers — A sweep rake mounted on the front of a tractor may be used to collect hay and bring it to various types of stackers. The hydraulically operated sweep stacker has largely replaced the separate sweeps and stacker.

Stack Movers — Stack movers are available that will handle stacks up to 16 feet wide and 30 feet long, and up to seven tons in weight. Stacks may be conveniently and economically moved over a considerable distance. It is suggested that two or more farmers share the cost.

Balers — Balers provide an economical method of processing hay for shipment or long hauls but do not reduce the man hours of labour per ton. Balers are available to make round or rectangular bales. The bale weight varies from 30 to 100 pounds, depending on the material, size of bale and the tension of the bale chamber. Wire or twine tie models are available. Twine is cheaper and most commonly used, but wire is preferred for commercial handling. A uniform windrow is essential for efficient and trouble-free baler operation. Moisture content should not exceed 20 per cent.

Bale Handling Equipment — Equipment is available which will reduce or eliminate manual handling of bales. In stacking, a loose layer of straw should be placed in the ground to prevent rotting of the bottom layer. Keep stacks narrow and well topped.

Wafering, Pelleting — Wafering and pelleting machines for long or chopped hay are available commercially and offer some advantages in handling feed. Wafers are generally considered to be over two inches in diameter with the length greater than the diameter. Density of wafers and pellets ranges from 15 to 40 pounds per cubic foot, with about 25 pounds per cubic foot appearing the best, considering palatibility to cattle and handling characteristics. Power requirements for making wafers and pellets are high and moisture content is critical. Feed handling is made easy.

Forage Harvesters — Forage harvesters are available in three main types — reel type cutter, flywheel cutter and flail type. The first two have a cutting or chopping action which is adjustable for cuts from ½ to four inches. The flail has a shredding action which does not cut the material uniformly.

Reel and flywheel type harvesters may be fitted with direct cut attachments for making silage, or pick-up attachments for picking up windrows. Flail machines perform these operations without attachments. Corn head attachments are available for reel and flywheel harvesters. Flail harvesters are not recommended for corn.

SPRAYING AND DUSTING EQUIPMENT

Farm Sprayers — Farm sprayers can be obtained for either low-pressure-low-volume or high-pressure spraying. Low-pressure units are designed to apply sediment-free pesticides and are normally equipped with a gear pump or a roller-vane pump. High-pressure sprayers are designed to apply a wide range of chemicals, including wettable powders, and are normally equipped with a piston or plunger pump and a mechanical agitator.

Consider carefully the type of spraying to be done when purchasing a sprayer. The herbicide sprayer should not be used to apply an insecticide to a herbicide-sensitive crop. Use separate sprayers for herbicides and insecticides. In an emergency, when the herbicide sprayer must be used to apply an insecticide, decontaminate the sprayer as follows:

Flush out the sprayer with kerosene to remove traces of oil-soluble pesticides. Run a solution of warm water and household detergent through the machine and then flush with clean water. Fill the tank and system with a mixture of household ammonia and clean water, (one gallon to 100 gallons) and leave the mixture in the tank for 24 hours or longer. Run the mixture through the machine and flush with clean water.

Dusters — Dusters may be used to apply herbicides or insecticides in the dust form. They may be operated at somewhat higher field speeds than are used for sprayers.

MACHINERY FOR IRRIGATION

Ditchers — Three types of ditchers are: the fixed-double-wing, the adjustable-double-wing and the adjustable-single-wing. Double-wing units form field ditches without the preliminary use of a plough. A plough furrow is necessary with the single-wing unit. Two or three trips are required to form a properly shaped ditch with firm, high banks.

Float Levellers — Float levellers are used to smooth small surface irregularities on a field that is to be irrigated by gravity methods. They are equipped with either an automatic hydraulic control for the scraper blade or a mechanical linkage between the blade and gauge wheels or a gauge plate. It is frequently desirable to pull harrows behind the leveller to roughen the field slightly to help prevent soil drifting. Home-made levellers should be at least 20 feet long and not over eight feet wide for good floating action. An eight-foot blade on a commercial unit requires at least a four-plough tractor. A 10-foot blade should be pulled by a five-plough tractor.

Ditch Fillers — Tractor-mounted plough, mounted in-throw discs, and mounted grader blades can be used for filling field ditches before the crop is harvested. Mounted disc-type bedders have given good service for this purpose.

Scrapers — Small carry-all or bucket type scrapers, varying in capacity from one cubic yard and upwards, are useful for small earth-moving jobs on the farm. Major land-shaping and earth-moving projects usually justify the use of industrial equipment.

Sprinkler Irrigation Equipment — Many types of sprinkler systems are available. The conventional hand-move system usually costs less initially and is more adaptable than other systems. Most of the other types, including tractor-tow, wheel-move, rotating-boom, rotating-lateral, and stationary or self-propelled, large-volume, high-pressure, single-nozzle types, have been developed to reduce or eliminate field labour. All of these are considerably more expensive and most of them have other disadvantages, which may include :

(1) Considerable difficulty in moving the system from one field to another.

(2) Elaborate mechanisms more subject to breakdown.

(3) Increased pumping costs in the case of those operating at high pressure (70 to 100 p.s.i.).

(4) Severe distortion of application patterns by wind for all models discharging large volumes of water from a single large nozzle.

(5) Occasionally, the application rate is greater than the soil infiltration rate.

Regardless of the system chosen, it is important to remember that the system should be designed specifically for the soil and crop on which it is to be used. Designed pump capacity should not be less than seven gallons per acre, per minute. The design for the total system should be obtained from a competent agency in order to ensure maximum efficiency.

POWER MACHINERY

Plow Capacity of Farm Tractor

Table shows relation of approximate plow capacity in terms of 14-inch bottoms and observed drawbar horsepower, (from Nebraska tests) and also practical field horsepower rating.

Approx. Plow Capacity in 14" bottoms	1	2	3	4	5	6
Observed Drawbar H. P. (Neb.)	11 to 19	19 to 31	31 to 43	43 to 55	55 to 67	67 to 78
					7	8
					78 to 91	91 to 103
*Available H. P.	7 to 11	11 to 18	18 to 26	26 to 33	33 to 40	40 to 47
					47 to 54	54 to 61

* Available Horsepower—Under practical filed conditions the available horsepower is less than the Nebraska observed H.P. because of the following conditions :

1. Reserve Consideration — assumes 75 per cent loading to allow for field irregularities.
2. Altitude effect — Alberta is from 2,000 to 4,000 feet above sea level. This reduces the power output.
3. Temperature effect — The Nebraska ratings are based on 60 F. Temp. Operation at higher temperatures reduces power.
4. Engine Condition — Nebraska test engines are tuned up to peak performance. The average tractor in the field is at least 10 to 15 per cent below this peak.
5. Field and tractor condition — Nebraska tests are conducted on level track with good traction. As much as 5,000 pounds of balast is used. The average tractor does not have ideal operating conditions.

The available horsepower should be used to match tractor to equipment.

TILLAGE NEEDS FOR HORSEPOWER

Table showing Horsepower Requirements of Tillage Implements in Different Soils

Implement	Depth Inches	Speed m.p.h.	H.P./ft. of Width by Soil Type		
			Light	Medium	Heavy
Plow - slow speed	4 - 5	3½	3	3½	4½
Plow - high speed	4 - 5	4½	4	4½	5¼
Disc plow	4 - 5	4	5½	6	6½
One-way disc	3 - 4	4	2	2½	2¾
Discer	3	4	1¼	1½	2
Blade Cultivator	3 - 4	4½	1½	2½	3½
Cultivator	3 - 4	4½	2	2½	3
Rod Weeder	3	4	¾	1	1¼
Drag Harrow	—	4	⅜	—	½
Oscillating Harrow	—	4	⅜	—	½
Seed Drills	—	4½	¾	1	1¼

Table of Horsepower Requirements of Haying and Harvesting Machines

Forage Harvester ½ inch cut	1 to 3 (PTO) H.P./ton/hour
Combine — P.T.O.	2 to 4½ (PTO) H.P./ft. of cutter bar
Hammer Mill	½ to ¾ H.P./bushel hour
Plate Grinder	⅛ to ½ H.P./bushel/hour

Characteristics of Different Power Sources at Various Loads
Increase in Fuel Consumption Per H.P. Hour at Part Loads, expressed as per cent increase over rated load

	Rated	¾ Load	½ Load	¼ Load
Gasoline and propane	0	10	33	100
Diesel	0	5	20	80

This table illustrates that the diesel is more efficient than the gas or propane engine at part loads.

Selection of Power Unit — Power plants should deliver sufficient power at the specified speed with maximum operating efficiency. Internal combustion engines and electric motors are by far, the most common types of power units.

Electric motors have many advantages over internal combustion engines, such as ease of starting, low initial cost, low upkeep, wide range of operating temperature tolerance, long life and suitability for mounting on horizontal or vertical shafts. Direct drives are possible, eliminating gears and belts. Water tight vertical motors are available for deep well operation. On most farms, a limitation is placed upon the size of electric motor by the power company. The maximum size may be five h.p. or in some cases 7½ h.p. For larger power requirements, three phase supply is required.

A comparison of the fuel costs for tractors burning different fuels is shown in the following table :

AVERAGE FUEL CONSUMPTION WITH DIFFERENT FUELS

Fuel Consumption — gal./hr.

Belt H.P.	Gasoline	Diesel	Propane
10	0.72	0.55	0.97
20	1.44	1.11	1.95
30	2.16	1.66	2.92
40	2.88	2.22	3.89
50	3.60	2.77	4.87
60	4.32	3.32	5.84
70	5.04	3.88	6.81
80	5.76	4.44	7.78

To compare fuel costs for tractor operation use the current fuel prices in your area and the fuel consumption data shown above.

For continuous operation with various power sources, best results are obtained with the following loadings:

Electric Motors	—	100 per cent full load rating
Diesel Engine	—	80 per cent full load rating
Gasoline or Propane		
—water cooled	—	70 per cent full load rating
—air cooled	—	60 per cent full load rating

Traction — The traction capacity of a rubber-tired tractor is approximately proportional to the total weight on the driving tires. The maximum drawbar pull is approximately one-half the weight on the driving wheels. If the tractor provides insufficient weight, ballast can be added to the rear tires, or weights can be fastened to the rims. Tires should not be loaded beyond the manufacturer's recommendation. Liquid ballast should be a calcium solution for frost protection. There is no significant difference in traction performances between the use of liquid, dry, or cast iron ballast. Also, there is little difference in performance between different tread designs. Tire inflation pressures should always be sufficient to prevent side wall flexing.

The track-type tractor can exert a higher drawbar pull than the rubber-tired tractor with the same total weight. Tracks reduce ground pressure and rolling resistance in loose, soft soil surfaces. Land clearing operations are best carried out with tracks or steel wheels. Crawler tractors are not widely used on sandy soils because of high track maintenance.

Remote Power Application — In addition to power being delivered and used at the drawbar, it can be transmitted to the implement by other methods.

Belt — The belt was the first method developed, but is now being replaced by the other methods.

The standard belt speed is 3,100 feet per minute, plus or minus 100 feet per minute. Belts should never be put on or pulled off while there is power in the driving pulley.

Power Take-off — The A.S.A.E. - S.A.E. PTO standard adopted in 1963 provided for a speed of 536 plus or minus 10 r.p.m. Since then, there have been increased power demands upon PTO drives and more capacity is required. This is being accomplishd by increasing the standard speed to 1,000 plus or minus 25 r.p.m.

Until all tractor PTO and implement shaft speeds are the standard 1,000 r.p.m., conversion kits will be required. These may be obtained where the tractor PTO is 1,000 r.p.m. and the implement shaft 536, or when the PTO is 536 and the implement is 1,000. The manufacturer's instructions should always be followed in adjusting and operating PTO shafts and safety shields must always be kept in place. The tubular shields are non-removable.

Hydraulic Systems — Hydraulic controls for farm equipment are very flexible and have a wide range of application. There are two general types of control systems:

(a) Limit control,
(b) Proportioning control.

In limit control, the implement is raised or lowered by moving the control lever to either side of its neutral position. The piston in the power cylinder continues to move until the lever is returned to neutral or until the travel is limited by a stop. The position of the implement is adjusted by visual observation.

In proportioning control systems, the position of the lever indicates a definite depth or draft of the implement. There are two types of proportioning control systems: In automatic position, the hand control lever indicates a definite depth of implement. In automatic draft, the hand control lever indicates a definite draft of the implement.

The oil used in an hydraulic system is very important. The manufacturer's recommendations should always be followed. Dirt is the greatest enemy of an hydraulic system. The oil should always be kept clean and the quantity maintained at the proper level.

Hydraulic motors are another means by which power can be transmitted to remote locations. One advantage of the hydraulic motor is the flexibility of the hose which can be taken to otherwise difficult locations.

Electric Generator and Motor System — An electric generator can be driven from the engine of a tractor and the power used to operate an electric motor or motors, either stationary or on a moving implement. This system provides a maximum flexibility because the electrical wires can be taken easily to any location.

A standard A.C. generator supplying 110 - 220 three phase power is available and this can also be used as a stand-by unit in case of regular power line failure.

FARM BUILDINGS

Buildings have been one of the last areas in farming to be influenced by the changes in production patterns which the industry has experienced in the past 25 years. The permanence of buildings and the relatively high capital investment involved have not been compatible with change. However, the trend towards larger production units and the need for increased labour and animal efficiency has emphasized the limitations of traditional building designs, while, at the same time, creating problems which did not previously exist. This has resulted, in less than a decade, in a host of developments in design, together with an increasing awareness that buildings should not be considered in isolation but as tools in production processes.

A building as such does not make a profit — it is the animal or produce housed or stored within which does this. A portion of this profit must go to give a reasonable return on the capital invested in the building and as well cover the depreciation, insurance, and maintenance on it. The calculation of the animal charge for the building per animal space or per ton of produce stored is essential in farm budgeting.

A low annual charge in respect of a building is not necessarily reflected in high returns on the enterprise for which it is used, as a cheap design may result for example in poor labour efficiency or thrift of stock. The annual charge must be considered in relation to the total costs of production of the enterprise and indeed, in most instances, of the farm as a whole.

The rate of technological development within the industry today is such that buildings, particularly for livestock, rapidly become obsolete. It is most important to realize that the useful or functional life of a building, with the possible exception of general storage structures, is considerably less than its structural life. Generally, the more specialized the building, the more rapidly it should be written off or depreciated. Intensive pig buildings for example should be written off in 10 years or less and machinery stores in 25 to 30 years.

Flexibility in farm building design is a most desirable objective, but true flexibility with interchangeable building components to meet a range of specific needs still lies in the future. In practice, it is best to aim for a sound functional design which will meet:

(a) the specific requirements in the light of present knowledge,

(b) the particular circumstances on the individual farm.

A specialist building, properly designed, is likely to fulfill its function more efficiently, and at a lower cost, than one which is designed with the possibility of alternative uses in mind, as such a design must involve compromise to a greater or lesser extent.

One of the developments of recent years has been the intensification of livestock enterprises with increased emphasis on housing of a specialized nature. This trend lends itself to industrialized building methods. Neither the facilities nor the necessary skills are available on the majority of farms to undertake some of the work involved, while at the same time farm labour is becoming more difficult to obtain and more expensive to employ. Thus the factory-made farm-assembled building will probably provide an increasing portion of farm buildings erected in the future. The day may not be too far off when farmers will buy their buildings in the same manner in which they at present buy tractors or combine harvesters.

Farm buildings are a feature of the landscape in any rural community. Simply because they are farm buildings is no justification for failure to ensure that they are not pleasing in appearance. A well designed farmstead with well maintained buildings and yards creates pleasant surroundings for the farmer and his family, as well as being an asset to the community. Better use might be made of the wide range of buildings materials available today, not only to improve appearance, but to reduce routine maintenance.

Decisions concerning the construction of buildings, because of their long term implications and the capital involved, should not be undertaken without most careful thought. If a piece of equipment is purchased which turns out to be unsuitable, it can be traded in for another. This is not the case with buildings, and therefore a wrong decision may have serious consequences. The first essential therefore in planning buildings is to review the farm business and policy as a whole. The services of farm management specialists should be sought where possible.

Once the decision to go ahead with a building or buildings is reached, the following suggestions are made as a guide toward ensuring that the money is well spent:

a) Make full use of extension services. Agricultural engineers and livestock specialists will provide technical information on all aspects of construction, layout, etc. Excellent pamphlets and plans are available from university agricultural extension departments, government departments of agriculture and commercial concerns.

b) Make a point of seeing buildings and layouts of the type planned. The experiences of operators can be most valuable in the planning and snags and possible improvements can be fully discussed.

c) Plan to allow for possible future expansion of the new unit so as not to interfere with possible expansion of other buildings and enterprises.

d) Check with the appropriate authorities that the site does not contravene regulations such as distance from power lines, highways, etc.

e) Calculate the total costs involved, including access roads, fences, services, etc. Costs can be obtained from a variety of sources including suppliers of materials, contractors, and manufacturers.

f) Draw a plan of the building or lay-out or have plans prepared. Even though these may cost some effort or money, changes or alterations can be made much more cheaply on paper than they can once construction has commenced.

g) Decide how the work is to be undertaken. If it is to be done by contract, it is advisable to have plans and specifications properly drawn up.

ELECTRICAL POWER

The use of electrical power on the farm is expanding rapidly and is generally available as 115/230 volt single phase A.C. It is an economical and flexible source of power that can be utilized for lighting, motive power, and heating. Electric power is very adaptable to automatic and semi-automatic installations that will reduce labour requirements.

A permit, obtainable from Electrical Protection Branch, Department of Labour, is required for a new installation or additions to existing wiring. Where an electrician is employed he will obtain the permit. If the farmer is doing the work himself, he must obtain the permit. In the case of a new service connection, the permit is the authority for the power company to supply the installation.

Planning the System — Before a building is wired it is desirable to plan the wiring carefully so the service entrance and wiring are adequate to handle future requirements.

The farmstead may be wired with the conventional overhead system. However, underground wiring presents advantages, and the installation costs are approximately the same. The system should be planned so that the water pump will be operative for fire fighting, even when power has been cut off at the buildings.

Protective Equipment — The circuit breakers in the service entrance panel will provide overcurrent protection. However, an electric motor requires overload protection. Without the overload protective unit, it is possible to burn out the motor even though there is not sufficient current to trip the circuit breakers.

NEMA grounded outlets are required in all farm installations, to provide protection against electrical shock from faulty electrical equipment. In addition, wired electrical equipment must be grounded permanently. Grounding of electrical equipment, such as electrical watering bowls, is particularly important to protect livestock.

When purchasing any electrical equipment for the home or farm, make certain that it has C.S.A. (Canadian Standards Association) approval.

Heat Lamps and Cables — Improper use and installation of heat lamps constitutes a hazard. Approved lamp receptacles should be used. The unit must be suspended by a chain and not by the cord. Farm Wiring Regulations outline additional requirements for heat lamp installations.

Electrical heating cables are widely used for underfloor heating, and electric heating tapes.

Motors are used for frost-proofing pipes. The speed of the driven machine should be considered when selecting an electric motor. Electric motors are generally available in speeds of 1,140, 1,725, and 3,450 r.p.m.

In many areas three phase power can be economically obtained on the farm, allowing the use of multi-phase motors. These motors have lower initial and maintenance cost than comparable size single phase motors and much larger motors can be used.

STARTING CHARACTERISTICS OF SINGLE PHASE ELECTRIC MOTORS

Type of Motor	Starting Torque	Maximum Starting Current
Split Phase	Low, 1 - 2 times running torque	High, 5 - 7 times running current
Capacitator	Medium, 2 - 4 times running torque	Medium, 3 - 4 times running current
Repulsion Induction	High, 3 - 5 times running torque	Low, less than 3 times running current

See References.

FARM UTILITIES

Water Supplies

The well is the most common source of a farm water supply and generally is free of disease producing bacteria. In some cases, well water may contain salts that impair the quality. However, in most cases they can be removed. If a well is contaminated, it is generally by surface water entering the well. This can be prevented by sealing off the top against infiltration. Surface drainage should be provided away from the well. Springs are a form of well, and generally provide a good source of water.

Dugouts, streams, lakes and ponds will generally provide an adequate supply of water. However, if used for domestic purposes, they must be filtered and treated.

Water Systems

The type and size of the pumping unit will depend on the capacity of the well, volume of water to be used and the depth of well. A jet pump has the advantage that it need not be located directly over the well. However, it is not desirable for use on a low capacity well, or a well where the lift exceeds 100 feet. The reciprocating pump, and particularly the balanced beam type of pump, is recommended for low capacity wells and can be used for any depth required. The submersible pump is generally used as a deep well, high capacity pump.

Piping

Any yard piping should be placed at a minimum depth of eight feet underground to prevent freezing. Three-quarter inch pipe should be the minimum size for yard piping. In many cases, a larger size may be necessary to ensure an adequate flow of water, particularly where water is moved long distances. Polyethylene pipe is easy to install and low in cost. Galvanized pipe and copper pipe are more difficult to install in trenches and the cost is higher. Copper or galvanized pipe should be used for inside water pressure lines, and rigid plastic should be used for drain and vent lines.

Sewage Disposal

Safe sewage disposal on the farm is an important health consideration. The septic tank system has been proved the most satisfactory. The septic tank should be a two-compartment type with a syphon or pump chamber to help prevent freezing of the sewer line.

Corrosion generally limits the life of a steel tank from seven to 10 years. A more permanent type tank such as concrete or an approved fiberglas is recommended.

There are several methods of disposing of the effluent, such as the use of a field, leaching cesspool, above ground filter, sand filter, pumpout cesspool, and the surface evaporation pad. The system to use will depend to a great extent on the conditions around the farmstead, such as the porosity of the soil, slope, and proximity to wells.

Heating

Alberta farmers have a choice of fuel. Natural gas is the cheapest, and, where available, will normally be used. Where natural gas is not available there is a choice of coal, oil, propane and electricity. The cost of electricity may make it prohibitive for heating the home or farm buildings. However, there are applications such as heat lamps, radiant heaters and water heating, where it may be used to advantage. Coal, oil or propane may be used for heating the home or other buildings. An automatic coal stoker furnace will normally cost more to install than oil or propane. The fuel costs of coal will be low, but the fuel is not as clean to use as oil or propane.

The following table will give the comparative costs of each fuel at various prices :

FUEL COMPARISON TABLE

Fuel	Price	Heat Content	Efficiency	Useful Heat for each cent
Natural Gas	33⅓¢/M cu. ft.	957 BTU/cu. ft.	75%	21,500 BTU
	50¢/M cu. ft.			14,300
	80¢/M cu. ft.			8,960
Coal (Tofield)	$8.00/T	8,000 BTU/lb.	50%	10,000
	6.00/T	8,000 BTU/lb.	50%	13,300
(Drumheller)	16.00/T	10,000 BTU/lb.	50%	6,250
Oil	12¢ per gal.	168,000 BTU/gal.	75% (gun)	10,500
	20¢ per gal.	168,000 BTU/gal.	75% (gun)	6,300
	15¢ per gal.	168,000 BTU/gal.	75% (gun)	8,440
			65% (gravity)	7,380
Propane	11¢ per gal.	109,000 BTU/gal.	75%	7,420
	12¢ per gal.	109,000 BTU/gal.	75%	6,810
	15¢ per gal.	109,000 BTU/gal.	75%	5,440
	18¢ per gal.	109,000 BTU/gal.	75%	4,540
	20¢ per gal.	109,000 BTU/gal.	75%	4,080
	25¢ per gal.	109,000 BTU/gal.	75%	3,270
	30¢ per gal.	109,000 BTU/gal.	75%	2,720
Electricity	2¢ per kwh	3,412 BTU/kwh	100%	1,706
	1½¢ per kwh	3,412 BTU/kwh	100%	2,559

The efficiency of the heating unit has been considered for each fuel so these costs are comparative.

e.g. — Compare coal at $8.00 per ton with propane at 15¢ per gal: from the table:

Under the column "Useful Heat for Each Cent" coal at $8.00 per ton will provide 10,000 BTU's for one cent, and propane at 15¢ per gallon will give 5,440 BTU's for one cent. At the above mentioned prices, propane provides approximately one-half as much heat for one cent, or in other words, the cost of heating with propane is twice that of coal in this case.

MATERIALS HANDLING SECTION

Materials Handling is any operation which changes the location of a material; the moving of things from one place to another. Traditionally, the fork and shovel were used. While it has been known for 50 years, that a 22-pound shovel or forkful is the best size for man-powered shovelling, electricity and other sources of energy are now cheaper than man-power and should be used whenever the materials handling is repetitive enough to justify the cost of equipment.

Materials handling consists of three basic parts, picking up, carrying, and putting down. Any materials handling problem must view all three together and must as far as possible, employ the same equipment for as many materials as possible.

A second rule of materials handling is that materials should only be handled once, and that other operations should be eliminated or simplified to reduce double handling to the minimum. For example, processing the material when it is in transit. A third rule is that if processes must take place between handling, then the direction of movement should be kept logical and over as short distances as possible.

The following brief paragraphs describe the handling of materials according to whether they are regular, non-flowing or liquid. The type of handling equipment used will depend both on the type of material and on the type of movement. It may be between fixed points, or between points in a limited area, or between points within a wide area. In the last group are cranes, hoists, and augers and in the first group, conveyors and elevators.

An important consideration is the amount to be handled and the frequency of handling. It is generally cheaper to handle a small quantity continuously than a large quantity infrequently. Many automated pig, poultry, and cattle feeding systems rely on small horsepower motors which provide a continuous flow of fluidized (material agitated so that it flows like water but does not contain any liquid), pellets or meal. If materials flow, then they have much cheaper and much simpler handling characteristics.

Questions in Planning Materials Handling:

1. What is the shortest route?
2. What is the material?
3. Can the material's shape or form be altered to become more convenient for handling?
4. Can the handling be eliminated or combined with another operation?
5. Can the handling be simplified and combined with the handling of other materials?
6. How much material is to be handled?
7. What is the value of the material when it is handled?
8. Is it necessary to handle the material indoors and use valuable space?
9. Are the stores before and after handling, sufficiently large? What is the best size for them?
10. What is the cheapest form of power available — after gravity?
11. What equipment is available to move the material, (conveyors, elevators, cranes, hoists)?

THE PROPERTIES OF MATERIALS

The quality of most agricultural products depends upon the care with which they have been handled. For example, milk must have clean hygenic pipes. Potatoes must not be allowed a free drop of more than two inches if they are not to become damaged. Grain for seed purposes must not be allowed to be hammered, boot-trodden on, or clipped by any mechanical device which would damage the germ. It is likely that the emphasis on care of handling will increase as agriculture becomes more advanced. A knowledge of the properties of materials

to be handled, that is, agricultural produce, is thus most important. A separate reference is given which gives details of this type from the Agricultural Materials Handling Manual.

Agricultural materials do have certain strange characteristics. For example, cubed shaped bales of hay or straw can be random stacked and can be removed with a fork lift from such a stacking pile or heap. If the bales are the normal, long, thin, shape they will become irretrievably tangled.

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Section 5.2 Systems .....
Section 5.3 Automation .....

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Section 6.1 Functional Requirements .....

Part VII — **Properties of Materials and Engineering Data**

AGRICULTURAL ECONOMICS

Economics is a necessary part of agriculture. Each time a decision is made by a farmer or a rancher he must use economics. These decisions include a variety of items in the every day life of agriculture. Decisions on buying, selling, feeding, breeding and seeding all encompass economics in the agricultural setting. Hence, this section deals with the principles vital to the successful operation of the farm or ranch as a real business operation. In the material which follows, the major areas of farm management and marketing are discussed. A section on business arrangements, and credit concludes the chapter on agricultural economics.

FARM MANAGEMENT

Management is difficult to define. Yet the ability to manage must be important. Some individuals become successful in their businesses. Others with similar resources do poorly or fail completely. Some do not take the time or lack the ability and patience to weigh alternative courses of action regarding risk, profit, opportunity and feasibility.

Farm management deals with the organization and operation of a farm, attempting to make the greatest continuous profit. It places the farm operation on a business basis, producing at the lowest possible cost and selling at the highest possible price.

Farm management deals with the process of making sound decisions by using proven economics principles.

Sound decision-making involves the following steps, all of which are necessary :

1. Recognizing the basic problem.
2. Looking for alternative solutions.
3. Analyzing to select the best solution.
4. Taking action on the selected alternative.
5. Bearing the responsibility of the outcome.

This section deals with the tools of sound business management, namely :

1. Farm records.
2. Farm Business analysis.
3. Budgeting.

FARM RECORDS

Farm records are not an end in themselves. They are an indespensible link in the chain of business practices leading toward better planning and more effective use of farm resources.

A recording system must give a simple yet accurate picture of the farm business. It should include both financial and physical information (for example, crop yields and feed conversion). Facts concerning past performances lead to better decisions for the future.

The main reasons for keeping farm records are :

1. **To Give a History of Performance of the Farm**

   A complete record over the years shows the operator whether or not he is increasing the financial position of his business. An increasing yearly net worth statement shows that his assets have earned more than enough to provide his family's living costs. A declining net worth statement is a warning for him to stop and seriously examine his operations. A well-prepared profit and loss statement will help him analyze happenings regarding his "net worth" calculations.

2. **To Aid in the Control of Current Operations**

   Current farm records tell how the business is performing in relation to the plans of the operator. In many businesses outside of agriculture, monthly analysis keep a constant check of the operations. Even the busy farmer should insist on periodic checks to see if he is achieving his goals. Prompt detection of weaknesses in his business may prevent serious losses.

3. **To Provide Basic Information for Future Production Plans**

   Farmers, like other businessmen, need reliable and practical information in making plans for next month, next year and even five or 10 years from now. They need it for small adjustments or for major changes. Records give needed information on cost and price relationships, crop yields, rates of gain, butterfat production and so on. Such data are necessary for accurate budgetting. Off-the-cuff estimates may be quite inaccurate.

4. **To Provide Detailed Information for Income Tax Filing**

   Without records, small items of expense are forgotten. These can add up to a considerable sum over the year. A systematic farm account makes the task of filing income tax returns much easier. The tin can or shoebox file require a great deal of sorting at the end of the year. Chances are that bills were not received to cover all of the year's transactions. Discrepancies usually lead toward over-estimation of taxable income.

There are two basic financial statements which every farmer should prepare:

1. A net worth statement which includes a listing of:
   (a) Business and personal assets . . . and
   (b) Business and personal liabilities.
2. An operating statement which contains a cash account, a record of new debts and repayments of old ones and a financial summary. The forms for each of these accounts are usually included in good farm account books. One such account book is the **Prairie Provinces Farm Account Book** available through the local district agriculturalist.
3. A Net Worth Statement or Balance Sheet is a statement of the balance between the farm operator's assets (what he owns) and his liabilities (what he owes) at a particular point of time. This gives an appraisal of the operator's equity in the business. It must also include personal assets and liabilities in order to show his net worth. Total assets will equal liabilities plus the operator's net worth. The net worth or balance sheet is a snapshot of the operator's business affairs at a particular point of time, usually at the end of the calendar year. This is the type of statement the banker or other credit source demands when a loan is requested. Net worth statements tell the farm operator three basic things:
   1) The kind and amount of his assets and liabilities.
   2) The size of the net worth he has in these assets.
   3) The change in his net worth from the beginning of the year to the end.

OPERATING OR PROFIT AND LOSS STATEMENT

While a net worth statement tells the operator where he stands on a certain day, the operating statement explains how he got there. It fills in the gaps between net worth statements and measures his efficiency. The operating statement is a moving picture type of summary. The accumulation of information required to prepare an operating statement constitutes what most farm operators consider as bookkeeping. The majority pay their income tax as assessed from a cash operating statement. A few may choose to file on the accrual basis.

In the latter case, a rise in inventories is added to income while a drop in income is considered an expense. The accrual method gives a more accurate picture of farm operating expenses (input) and farm operating receipts (output). Thus, the accrual or inventory method is most satisfactory for farm management, regardless of which system is used for income tax filing.

The Necessary Steps

The following accounting steps should be taken to arrive at the proper conclusions about the business:

FARM OPERATOR'S NET WORTH STATEMENT

(Form 1)

ASSETS	Beg. Yr.	End Yr.	Change
Farm Assets			
Land	15,600	15,600	0
Buildings	6,570	6,241	—329
Total Real Estate	22,170	21,841	—329
Farm Machinery	12,360	14,076	1,716
Livestock	6,725	9,205	2,480
Crops & Supplies	4,670	4,634	—36
Total Farm Assets	45,925	49,756	3,831
Personal Assets			
Household effects	1,850	2,000	150
Cash on hand & in bank	1,200	1,350	150
Savings bonds	800	1,000	200
Other property	437	521	84
Total Personal Assets	4,287	4,871	584
Total Assets	50,212	54,627	4,415
LIABILITIES			
Farm Liabilities			
Land	12,000	11,500	—500
Machinery	0	2,500	2,500
Total Farm Liabilities	12,000	14,000	2,000
Personal Liabilities	0	0	0
Total Personal Liabilities	0	0	0
Total Liabilities	12,000	14,000	2,000
Operator's Net Worth	38,212	40,627	2,415
Total Liabilities	50,212	54,627	4,415

Step One. At the beginning of the accounting period (usually January 1) list the inventories of farm assets showing type of asset and the present market value. The present market value as determined at the time of inventory is a more realistic value to the owner than using an artificial percentage rate or income tax rates which often do not reflect the true present market value to the owner. The inventory of farm liabilities are also listed at this time. The opening net worth statement is then prepared as outlined in form one.

Step Two. List the farm business expenses and receipts as they occur throughout the year. One must be careful to differentiate between capital expenses which are purchases of items (assets) lasting for several years. For example buildings, machinery and in certain cases long term repairs or tools. Operating Expenses are items to be used up within the accounting year. This includes seed, gas, oil and short term repairs. Operating expenses are listed as the example in Form 2. There is no sharp line between the two types of expenses. But they affect the profit and loss statement differently. Similarly, it is necessary to separate capital sales of equipment or real estate from the operating receipts of farm production such as crops or livestock. Form 3 lists operating receipts.

1. The forms contained in this guide include hypothetical or illustrative figures to enable the reader to more clearly follow the examples.

CASH FARM EXPENSES

Date	Number or Amount	Description of Item	Total Value
January 2	500 gals.	Tractor gas	$ 100.00
April 2	5 tons	Fertilizer	400.00
etc.	etc.	etc.	etc.
etc.	etc.	etc.	etc.
TOTAL CASH OPERATING EXPENSES			$ 3,552

(Form 3)

CASH FARM RECEIPTS

Date	Number or Amount	Description of Item	Total Value
February 4	25 hogs	Hogs sold	$ 981.00
February 14	150 bu.	Wheat	188.00
etc.	etc.	etc.	etc.
etc.	etc.	etc.	etc.
TOTAL CASH OPERATING RECEIPTS			$ 8,029

Column headings are flexible and should be set up to be of most use to the type of operation concerned.

Step Three. At the end of the year, prepare a closing inventory of assets (besides the opening inventory for ease of compilation and comparison). By preparing a closing inventory of liabilities at this time one also has the closing net worth statement as shown in Form one.

Step Four. Summarize the year's business by preparing a profit and loss statement to arrive at net income. Two alternative approaches can be used to determine whether this net income is a fair return. By deducting from net income the interest paid out in liabilities and an interest rate on the operator's equity, one arrives at the operator's labor earnings. The operator must compare this figure to alternative forms of employment open to him. The second approach involves deducting a wage based on the operator's alternative employment opportunities. The remaining figure is a return to capital. This can be expressed as a percentage of the capital he has invested in the business.

Form 4 represents one basic profit and loss statement. There are several forms available. None-the-less, an essential part of the operator's profit and loss statement is the adjustment made for increases or decreases in crop and livestock inventories. Although these are not cash items within the accounting year, they are necessary to reflect the true production of the farm.

The foregoing steps comprise the basic requirements for preparing the two main financial statements, namely the net worth or balance sheet and the operating or profit and loss statement. These, together with physical records on crop and livestock yields, feed and labor usage, provide information for analysis of the farm business and for budgeting and income tax.

This brief survey of farm accounting principles is intended to indicate both the nature of the basic farm accounts and the usefulness of them. In recognition of the importance of farm accounts on modern farms with high investment and a large turnover of money, the Extension Department of the University of Alberta has prepared a correspondence course in farm bookkeeping which covers the whole subject in a thorough, but understandable way. Information about the course is available from the agricultural secretary at the Extension Department of the University of Alberta, Edmonton. Most district agriculturalists in Alberta carry on farm accounting schools as a regular part of their winter extension programs.

(Form 4)

PROFIT AND LOSS STATEMENT

	$	$
CASH OPERATING RECEIPTS:		8,029
Plus: Increase in crop inventory	—	
Increase in livestock inventory	2,480	
Less: Decrease in crop inventory	36	
Decrease in livestock inventory	—	
ADJUSTED GROSS FARM RECEIPTS:		10,473
Less: Grain and hay bought	—	
Livestock bought	380	
GROSS OPERATING REVENUE:		10,093
CASH OPERATING EXPENSES:		3,552
Plus: Depreciation on buildings & equipment	1,863	
Family labor	—	
TOTAL OPERATING EXPENSES:		5,418
NET INCOME:		4,675
NET INCOME:		4,675
Less: Interest paid out on liabilities	750	
Interest on owner equity 35,753 @ 5%	1,789	2,539
LABOR EARNINGS:		2,136
NET INCOME:		4,675
Less: Wage allocated to operator		2,905
RETURN TO CAPITAL:		1,770
% Return to capital: $\frac{1,770 \times 100}{49,753}$		3.6%

ANALYSIS OF MANAGEMENT FACTORS

Analysis of the year's business is the next step in the farm management process. Farm records are a guide during the year in making management decisions. They are useful at the year end to disclose weak and strong spots as they relate to profit.

Some factors affecting earnings are important. Others are less significant. Some are beyond control of an individual farmer while others can be regulated through sound business management. A successful farm business is one that pays all expenses, provides the farm family with the kind of living they desire and allows for expansion to take care of future goals.

Farm management studies in Alberta indicate that many farmers in every district attain these income requirements. Yet, even with similar weather, soil and price conditions, many do not achieve a satisfactory level of income.

Land, labor, capital and managerial ability are the resources of the farm operator. Wide differences between farms in the amounts and proportions of these resources cause profits to vary from farm to farm. Farm business analysis attempts to measure the efficiency with which each of these productive factors is used and to indicate ways to correct the difficulties that are encountered.

THE VITAL FACTORS

Differences between incomes on farms facing similar situations are associated with:

1. **Size of Business.** The number of crop acres and number of livestock units.

2. **Use of Labor.** Output per man.
3. **Use of Capital.** Turnover of investment.
4. **Crop Returns Per Acre.**
5. **Livestock Returns Per Animal.**
6. **Enterprise Combinations.** Lines of production.

It is not always good land or large acreage that puts a farmer in the high income group. Some of the higher incomes are produced on medium quality soils. Some smaller farms make higher incomes than some of the larger ones. Those with the most livestock or a particular type of livestock do not always make the most money.

Best results are obtained by that group of farmers who have favorable balances between and who give importance to all the six factors listed above. Studies in Alberta have shown that farmers who were at least average or better in these factors made as much as $5,000 to $6,000 more per year than those who were below average in all six items. About $500 to $1,000 was added to the net income of the farmer for each of the six factors in which he was average or above. It is more important to bring all of these factors up to at least average for the district than to raise any one of them alone. Once average levels have been attained in all, the objective should be to raise them all above district standards.

The first concern in farm business analysis is to compare the operation to predetermined district standards in these factors.

MEASURING THE SIZE OF FARM AND LABOR EFFICIENCY

The total acreage of the farm is not always a good measure of the size of the farm business. For example, an irrigated farm of 160 acres producing specialty crops could be a bigger business than a ranch containing two or three sections of low grade grazing land. A better measure of the size of business is the total investment in all farm assets including machinery and other equipment, livestock and all land owned and rented. The value of a year's production is also a good measure of the size of the business. But these two factors should be taken into consideration together with the amount of labor used when measuring size of farm.

MEASURING OVERALL CAPITAL EFFICIENCY

Rising wages and the shortage of farm labor has forced expensive farm mechanization. This has solved some farm problems, but has created others. On many farms, the investment in buildings and machinery now is greater than that of land. While the output per worker has increased, mechanization has introduced a new rigidity into the farm costs structure. It is important not to exceed safe economic limits in substituting capital for labor.

Every business including farming has a necessary rate of turnover on capital. Farmers whose gross yearly farm receipts equals the total farm investment in about four years are achieving a good capital efficiency. Some do this in as little as two years while others take eight or more years. Such low rate of turnover can be traced to over-investment for the size of farm business or to inadequate returns per animal or per acre.

MEASURING CROP EFFICIENCY

Most operators are conscious of the loss that can result from low crop yields. It is not so easy to assess in dollars and cents how the total crop enterprise compares to the district standard because of different proportions of wheat, oats, barley and other crops in the program. The crop index method measures the success of the cropping program.

The crop index is a percentage comparison of crop yields to the district average. It considers the weighted effect of all the crops and not just the best field which had the most favorable treatment. This can be measured by calculating a weighted average of all physical crop yields. One can get a reflection of quality and types of crops by combining the physical yield with prices. A low yield of a high-priced crop is more serious than a low yield of a lower-valued one. The monetary comparison can also be used to measure the intensity of the crop program.

Under this system, crop index is the value of the total crop as compared to its value if district average yields have been obtained. It is expressed as a percentage of the average. Form 5 will serve as a guide to rate your crops on a crop index basis. For more specific information about crop programs refer to the pertinent chapters in this guide.

(Form 5)

		YOUR FARM			DISTRICT AVERAGE		
Crops Grown	Acres	Yield Per Acre	Total Yield	Total Value $	Yield Per Acre	Total Yield	Total Value
Wheat	66	40 bu.	2,640 bu.	3,960	30 bu.	1,980 bu.	2,970
Oats	40	25 bu.	1,000 bu.	600	44 bu.	1,760 bu.	1,056
Barley	53	26 bu.	1,400 bu.	1,120	32 bu.	1,696 bu.	1,357
Forage Seed	66	45 lbs.	3,000 lbs.	600	45 lbs.	3,000 lbs.	600
Hay	120	1.25 T.	150 T.	3,000	1.6 T.	192 T.	3,840
Pasture	40	xxx	xxx	240	xxx	xxx	240
Fallow	94	xxx	xxx	xxx	xxx	xxx	xxx
TOTAL		xxxx	xxxx	A 9,520	xxxx	xxxx	B 10,063

Your crop index will be $\frac{A \times 100}{B} = \frac{9{,}520 \times 100}{10{,}063} = 94.6$ per cent of the district average yields.

MEASURING LIVESTOCK EFFICIENCY

In general, livestock efficiency amounts to the yield of saleable product per unit of each kind of livestock that is kept. In dairy production, records should be kept of milk production per cow. In hog production, the number of hogs per litter raised to market weight is the index of the efficiency of the enterprise.

In beef production, it is now recognized that individual animals and strains vary greatly in their ability to gain weight, and the efficiency of the way they use feed. Keeping records of these factors helps the livestock man cull out his poor performers and to concentrate on the production of the superior types. For more specific information about livestock production, refer to the pertinent chapter in this guide.

Selection of Enterprise Combinations

There is no simple way to determine the best enterprise combinations on a farm. Important items to consider in selecting the combination of enterprises on any farm are :

1. Relative profitability of different enterprises.
2. Soil type and the amounts of tillable and untillable land.
3. The effect on labor distribution throughout the year.
4. Farm size and location in relation to special markets.
5. To a certain extent the preference of the operator.

Farm business studies show that enterprise combinations limit possible farm income when :

1. An enterprise contributes less than 20 per cent to gross income.
2. When there are more than two livestock enterprises in addition to the usual crop enterprise.
3. When the enterprises compete seriously for the farmers' management and labor at peak seasons.
4. When a more profitable enterprise or combination of enterprises suitable for the district and soil type is being ignored.

Too many enterprises usually means that management will be spread too thinly to be effective. Also, a large number of enterprises on a typical size of farm means that one or more of them will be too small to mechanize adequately. A small enterprise may contribute very little to receipts in relation to the extra expense and labor involved.

BUDGETING

Budgeting is the planning stage of farming. The farmer who is alert will spend considerable time making and revising plans and examining various crop and livestock systems. From these he will select the ones which promise the best income for the business as a whole. Many operators make no formal or written plans, but estimate in a rough way and count on working out the details as they occur. The man with considerable experience and skill can plan or budget in this manner for a simple business. Farming has become a complex business. An error is less likely if major decisions are made with the aid of a more definite and formal plan.

The purpose of budgeting is to compare alternative plans for prospective profit. It is not a matter of setting down a single plan to be followed without deviation. The budget may very well have to be changed and adjusted as conditions change and as more knowledge comes to the manager. It may be necessary to work out alternative budgets to see which will use the farm families' resources to best advantage. Once a decision has been made, the written budget can be very useful in checking actual progress against that anticipated.

TWO GENERAL TYPES

Two types of budgets are commonly used: (a) the partial budget and (b) complete budget.

The partial budget is a useful tool for planning changes in an existing operation. A projection of additional costs and additional returns can be made for such things as adding or deleting enterprises, trading one machine for another, etc. Form 6 illustrates an example of a change in one segment of the business that will not affect any other part of the operation.

The problem to be resolved in form 6 involves an operator who has the alternative of custom hiring, as he has been, or buying a baler to put up the 150 tons of hay he produces. While the conclusion of this operator was to purchase his own machine, this need not apply to another farmer faced with the same alternatives.

The complete farm budget is a useful tool for estimating the total costs and returns for next year. The illustration in Form 7 is a cash flow budget. The same problem as was resolved with the partial budget tool is now put through the cash flow budget to determine if it can be paid for out of the cash produced. All costs and incomes have been left the same as the previous year except for money borrowed, capital sales, capital purchases and loan repayments. Also note the decrease of expenditure in hired labor and custom work, and the increased expenditure in tractor, other equipment and crop costs. This cash flow budget presents a favorable picture in that with the same living costs, the cash on hand at the end of the year will increase from $1,350 to $1,697. His conclusion in this case is that he can finance the deal, yet maintain the present living standard of his family.

(Form 6)

THE PARTIAL BUDGET

Estimated change in Operator's Labor Earnings from the proposed change of buying a baler where he has previously done his haying on a custom basis.

Additional Annual Costs Expected

1. Fixed Costs

Depreciation	($2100 — 400)/10 yrs.	$ 170.00
Interest	($2100 + 400)/2 @ 6%	75.00
Insurance		——
Taxes		——
Others		——

2. Operating Costs	
Labor	——
Repairs	38.00
Feed	——
Fuel	112.00
Electricity	——
Other Twine	128.00
Reduced Annual Receipts Expected	——
Sub Total (A)	$ 523.00
Additional Annual Receipts Expected	$ Nil
Reduced Annual Costs Expected	
1. Fixed Costs	——
2. Operating Costs 150 T. @ $4.00/Ton	$ 600.00
Sub Total (B)	$ 600.00
Estimated change in Operator's Labor Earnings (B — A)	$ 77.00

OTHER CONSIDERATIONS

Extra Capital Needed $2100 ..... Degree of Risk ..... less .....
Extra Labor to Hire ..... Nill ..... Time lag till income starts ..... immediate

Other Advantages of Proposed Change :	Other Disadvantages of Proposed Change :
1.	1. .....
2.	2. .....
3.	3. .....

(Form 7)

THE COMPLETE FARM BUDGET

(An example of Cash Flow)

CASH IN FLOW	Crops	$ 2,202	$ 2,202
	Miscellaneous	400	400
	Livestock	5,122	5,122
	Capital Sales	175	——
	Money Borrowed	2,500	2,100
	Personal Income	267	267
	Cash on hand at start of year	1,200	1,350
	TOTAL CASH IN	$11,866	$11,441
CASH OUT FLOW	Car	60	60
	Truck	300	300
	Tractor	586	698
	Combine	175	175
	Other Equipment	26	64
	Crop	520	648
	Cattle	325	325
	Swine	316	316
	Farm Overhead (power, phone, taxes, insurance)	645	645
	Labor and Custom Work	600	——
	Capital Purchases	3,600	2,100
	Loan Repayment plus Interest	1,250	2,300
	Rent Payment	379	379
	Household and Personal	1,734	1,734
	Cash on hand year end	1,350	1,697
	TOTAL CASH OUT	$11,866	$11,441

MARKETING

Marketing considerations are of primary importance in most of the economic decisions made by farmers. A farmer may use the best technical know-how, manage effectively and produce efficiently, yet lose out in the market place because he did not keep well-informed on market conditions or use his knowledge effectively. While marketing usually is thought of as selling farm products, it also relates to purchasing farm supplies.

This section concerns the four major questions farmers must decide about buying and selling: what, when, where and how?

What to Buy and Sell? This question is often thought of as a subsidiary to the larger question of what to produce. Actually, the questions are dependent on each other. The basic production decision depends on market conditions in both purchasing and selling.

This is most obvious in such a decision as cattle feeding where the feeder must consider at the same time the markets for feeder cattle and feed and the probable future market for slaughter cattle. The same considerations are involved in all production decisions where the producer has to make a choice among alternatives. For example, a choice between two crops may be influenced as much by the cost of fertilizer or a new piece of machinery as by the expected relative prices of the products. The same considerations are involved in deciding how much to produce. Similarly, the choice between selling feed directly or through livestock depends on the relative markets for the products.

When to Buy and Sell? Proper timing of purchases may well mean the difference between profit and loss. The price of such things as feeder cattle, feed and fertilizer tend to be low some seasons of the year and high in others. While it may not be convenient to buy feeder cattle at the lowest price point in the year, a study of price patterns over a period of time may indicate that a change in the time of purchase would be advantageous.

Fertilizer dealers may be willing to sell or contract for spring delivery during fall or winter at a lower price than they would sell in the spring. Similarly, feed prices usually are lower at harvest time and increase through the year as storage costs are added to the price. However, it often is an advantage to buy at harvest time even if it is necessary to pay someone else for storage until the feed is needed

Periodic Price Movement. These are especially important in livestock. Several types of these changes can be distinguished. Trends are generally upward or downward movements over a long period of years and they usually pose no particular problems in timing of sales.

Another type of price movement is **the cycle**. Livestock prices move up and down inversely to the production cycle. For beef cattle, these cycles are about eight to 10 years in length. For hogs they are only about four years in length. It is not easy to predict when the turning point of the cycle will come. Frequently, farmers are caught by surprise and lose heavily on their operations as a result of an unforeseen reversal of the cycle. These cycles usually are caused by the concerted action of farmers to increase production when prices are high and to decrease production when prices are low. There is considerable advantage in doing exactly opposite to what the majority of producers are doing. It would even be better to maintain a constant rate of production than to change as most producers do.

Seasonal Variation

A third type of price movement is the **seasonal variation.** Slaughter steer prices usually are highest about August and lowest about September while fed calves usually peak in September and bottom in July. Hog prices on the average are at a maximum in August and a minimum in November. Lamb prices tend to be highest in July and lowest in October. These relationships may differ somewhat between markets and grades. In any given year, the influence of the cycle or other variations may outweigh the seasonal factor.

Irregular Variation. A fourth type of price movement is called the irregular variation. This type of change may be due to such diverse things as international disturbances, tariffs, droughts, pestilences, feed prices and supplies of competing

products. Most of these things are difficult to predict so the irregular variation is itself largely unpredictable. However, it must be taken into consideration in planning at least to the extent of realizing that it exists.

Where to Buy and Sell? The individual choice of a dealer is a matter of personal choice. Some farmers place a high value in trading with a particular kind of dealer — a co-operative, a home-town business, a personal friend. Other farmers prefer to compare qualities, services and prices and choose on the basis of the greatest economic advantage. There is something to be said for both approaches and for avoiding the extremes of either.

On the one hand, it does not make much sense to persist in patronizing a very inefficient dealer. On the other hand, buying from a dealer who charges very low prices may be a temporary advantage if his purpose is to drive out competitors so he can charge high prices later. In buying especially, it is necessary to compare quality and services before looking at price. In selling, it is desirable to compare grading, measuring and payment practices before looking at price.

It is often particularly difficult to assess the relative merits of trading with co-operatives and other kinds of businesses. A well-run, efficient, farmer-owned co-operative should set a standard of performance by which other businesses may be judged. It offers the farmer an element of increased bargaining power and competition without which he might be much worse off.

However, in individual cases, a co-operative may be less efficient than a competing business, so it provides no yardstick and offers no real advantage. It also is difficult to compare prices when the co-operative follows the practice of paying market prices set by other businesses and refunds whatever it has left at the end of the year.

Further difficulty is involved if the co-operative retains such amounts for a long or indefinite period. The producer who wishes to compare net prices must rely on past practices of the co-operative as a guide to the future.

Another type of comparison a farmer may make is between dealers at different locations or stages in the market process. For example, a cattle producer may sell to a local buyer directly, through a nearby auction, to a nearby abattoir or on consignment in a terminal market. Here, he may be concerned further with the choice of a commission agency. It is very difficult to determine the relative advantages in such a case except by experience, either one's own or a comparison of neighboring producers.

How to Buy and Sell? The farmer's decision of how to buy and sell largely determined by the dealers from whom he buys and by those to whom he sells. There are some cases such as selling certified seed, breeding stock, feeder cattle and specialty crops direct to consumers in which a farmer may use strategy in selling. That is, he may brand his products, advertise, arrange special sales or render special services which will give him a competitive advantage. However, for the great majority of things the farmer sells and almost everything he buys, these considerations are irrelevant.

How to buy and sell in most cases is simply the combination of what, when and where to buy and sell. The one factor the farmer can control to a large extent is the amount of market information he obtains and how he uses it. A poorly-informed producer is at the mercy of the dealer and various impersonal market forces. By exploiting the various sources of information available to him, the producer can greatly improve his decision-making.

The sources include his district agriculturalist, co-operative manager, field men and the various dealers with whom he trades. Published information is available from the Canada Department of Agriculture, Dominion Bureau of Statistics, Alberta Department of Agriculture, the University of Alberta and various farm magazines, trade organs and newspapers. Market news may be received by radio and special publications of various agencies.

Outlook Material. A special kind of information which is invaluable in planning production and marketing operations is **outlook material.** Both short range and long range outlook information reports are available from the federal and provincial departments of agriculture. The Agricultural Economics Division

of the Alberta Department of Agriculture publishes a quarterly newsletter, "The Alberta Farm Economist". This publication is distributed free to those who request it. It is available from the division direct or through the district agriculturalist or regional farm economist. A number of outlook publications and market trends are available from the Information Division, Canada Department of Agriculture, Ottawa, Ontario.

FARM RENTAL ARRANGEMENTS

The most common basis for the rental of crop land in the prairie provinces is the conventional division of the crop between landlord and tenant. Out of his one-third share, the landlord pays taxes and other expenses for upkeep of his real estate. The balance of the landlord's share is a payment for the use of the property. The tenant pays all the other expenses of crop production, including labor and equipment out of his two-thirds share of the crop.

Lease Principle and Calculation. Leasing arrangements for land represent a pooling of resources by the landlord and the tenant. In general, an equitable distribution of the proceeds of gross farm income should return a share to the landlord and the tenant that is in proportion to their contributions to the expenses of the production of the crops. The conventional one-third, two-third leasing arrangement should thus reflect a situation where the landlord's contribution is equal to about one-half that of the tenant.

The principle of sharing returns in the same proportion as costs are contributed is easy to recognize. But there are certain difficulties in measuring these contributions when they take the form of land on the one hand and labor and cash on the other. The first requirement in comparing the contributions of the landlordand the tenant is that both must be reduced to an annual basis. These contributions may then be set out and used as a basis for dividing gross income.

Real estate may be given an annual value by allowing for a return of interest on the investment, based on current interest rates and a fair valuation of land and buildings. The price for comparable land in the district provides the best evaluation. The rate of interest should be equal to that received from land mortgages.

The tenant under this one-third, two-thirds rental arrangement provides the labor, machinery and cash operating expenses. These factors must be given an annual valuation which may be compared with the allowance for interest made to the landlord. The value of labor may be judged from the current rate of farm wages. The necessary cash expenses are a matter of record-keeping.

The valuation of the machinery is more difficult since both interest on investment and depreciation must be considered. Values of farm machinery may be set in relation to local prices at auction sales and from dealers. An allowance for interest is first credited to the tenant on account of his machinery. Allowance for depreciation are not easily determined and no fully satisfactory standards are available. These rates should have a close relation to the life-time of the machine. They are often set too high by underestimating this life-time. For ordinary equipment on prairie farms, the following may serve as a guide: special equipment (truck, tractor and combine) 15 per cent; all other machinery, 10 per cent.

When the landlord's and the tenant's respective contributions have been determined in this way, they can be set down in a simple account to show the proportion in which these costs are shared by each and to serve as a guide for the sharing of gross income.

In practice, the division of costs will not be exactly in the one-third, two-thirds ratio mentioned. A tenant may have more equipment than is necessary. Giving him a full allowance for this equipment in calculating his contribution and claim on the proceeds would result in an unfairly reduced share for the landlord.

PROFIT SHARING CONTRACTS

The principles underlying any contracts in which profits are to be shared are no different than the principles of a fair rental arrangement for an entire farm. In taking cattle on share, for example, each party should be rewarded in the same proportion as they have contributed. The owner of the cattle usually contributes the fixed cost of interest on his cattle investment, replacement of old cows (depreciation) and, risk of death loss.

The person taking the cattle on share has to provide feed and shelter and the labor to look after them. There are also veterinary bills, minerals and so on to be bought. All these must be agreed upon and a fair value assigned to each contribution.

The gross income from the cows, and calves, can then be divided in proportion to the costs. This can often be better than simply relying on tradition because tradition does not change as rapidly as costs and technology do. A clearer understanding of the costs involved as well as their division can be a key to a better relationship between both parties.

Often the cattle owner feels the tenant is not taking proper care of the cattle. The tenant on the other hand, feels that the cattle owner is skimming off all the profit and not leaving him anything. It may be that both are right. It may also be that if there was a clearer understanding of what is going on that there would be increased profits from the enterprise and more money as the end result, to both parties.

Some basic points to remember are:

1. The contracts need to be economically sound to satisfy those involved. In addition, the legal implications must not be overlooked. A lawyer can put the thoughts of both parties down so that the contract is binding in the event of possible disagreements or misunderstandings later on.

2. That better tenants can be obtained if:

   (a) Security is offered through a longer term lease or contract. A tenant can only be expected to invest in items from which he can get his money back.

   (b) Adequate buildings and improvements are provided in a rental deal.

   (c) The productive capacity of the land or livestock in a livestock arrangement is high. It gives both tenant and landlord equitable returns based upon how much they contributed to the farm.

3. The landlords are more apt to be satisfied if the tenant takes initiative in conducting the production and marketing operations effectively.

   (a) The tenant does not mine the farm resources.

   (b) The tenant is receptive to general observations from the landlord.

FARM BUSINESS ARRANGEMENTS

In this age, the farm is facing a technological revolution. The number of farms is declining. Young people especially are leaving agriculture. To some extent this is something we must accept. As the productivity of those engaged in farming increases, those least able to compete will look for places where they will be able to compete outside agriculture. Those that remain must constantly adjust their operations towards greater economic efficiency.

As people leave the farm, there arises the problem of how to make a smooth transfer to the new owner, usually the new generation. This transfer most often takes place within the family itself. Dad retires and one of the sons takes over the place. This transfer is not something that can be done suddenly. Groundwork should be done early or various disappointments are bound to result.

The son should realize that the farm represents a life-time of work on the part of his parents. Provisions for their future economic well-being must be made.

In preparing for the final transfer of the farm, there will quite often be an interval in which both the father and son are actively engaged in the farm operations. Both are dependent upon it for their income. This should not present any problems if a proper farm business operating arrangement is adopted on a unit large enough to provide sufficient income for both families.

There are several arranegments which can be chosen depending upon the stage of preparation and the particular circumstances involved.

Formal Agreements

1. No formal agreement or perhaps only a verbal one. No one knows where he stands and only misunderstanding and trouble can result.

2. **Wage Agreement.** For a temporary period, the son may receive wages for his efforts. This should be supplemented at an early date by a more permanent arrangement that will add incentive to the son's interest on the farm.

3. **Enterprise Agreement.** The son has the major responsibility of one or more enterprises on the basis of self sustenance for each such enterprise. This enterprise should not be the only responsibility since he should learn the entire farm business.

Rental Arrangements

4. Rental arrangements on a share or cash basis. Generally a share basis is necessary because of the risk factor involved. This will give the son some responsibility in the farm operation.

5. **Father-Son Partnership Arrangement.** This should be written and should state the purpose of the agreement, the duration of the contract, the contributions to be made by each party, who should keep the records and how. Other arrangements would include the division of income, methods of settling arguments and the limitations on partners actions as well as provisions for final transfer. A partnership is not too expensive to establish. There is not too much "red tape" involved and the partnership can easily be dissolved.

On the other hand in a partnership, each partner is liable for the debts of the others. The transfer of assets is not clear cut. The partnership ceases on the death or withdrawal of one partner, regardless of how many there are.

Father-Son Partnership Agreements do offer a workable arrangement. If fairly laid out and properly executed, the partnership will fit well into the transferal scheme of the farm assets. Again, as in the cases of leases and contracts, legal opinion and help can be a big aid to avoid various pitfalls as time goes on.

6. **Incorporation.** Farms in Alberta may incorporate under the Companies Act. Generally, a farmer does not incorporate unless he has about $100,000 invested and has a taxable income over $11,000. As distinguished from a partnership, a corporation has perpetual existence. Shares are easily transferred and the shareholders are not liable for the debts of the company. There are possible tax advantages on high income farms.

However, corporations are more costly to establish. There are annual reports and audits to file. Corporations are more costly to dissolve. There may even be tax disadvantages on small farms.

Careful and detailed study should be given to these business methods of organization before any one of them is adopted. All angles of both the economic and legal implications should be investigated before a decision is made.

The farm transfer process is made more or less gradual through the use of the previously-mentioned methods. The final transfer will have to be made in one of the following ways:

(a) By Will.
(b) Agreement of Sale.
(c) By Gift.
(d) By cash and mortgage.
(e) Rental with purchase option.

Having decided upon who is to get the farm, there are several important considerations to bear in mind. There should be provision for adequate income for the parents and for the son getting the farm. There should be provision for compensation to children not getting the farm. There should be consideration for federal and provincial income and estate tax laws. The mutual consideration and approval of the plan by all parties involved should be obtained. It is important as well to consult a lawyer to be sure the plan is legal.

CREDIT

Credit is a method for getting control of an asset through the use of someone else's money. There is a right way and a wrong way to use credit. Whether it is right or wrong depends upon the user's financial position. It also depends upon the purpose to which he intends to put it.

Credit can be used for consumption. You must pay it back from future income. Consumption credit is used for immediate satisfaction and not to return a profit. It should be used for savings and for reasons of financial security.

If you borrow money for production, use it wisely. Do not borrow it at five per cent and use it where it will return only four per cent. When you borrow money, be sure that it is the best solution to your problem. Use it in the proper place on your farm.

Credit is quite often more easily obtained than it is paid back. Records and budgets as outlined in the previous section are useful tools to determine if credit will solve the problem. They also provide the information necessary for the orderly retirement of debt. A well-thought out plan goes a long way in improving your bargaining position with a prospective lender.

How Much Does Credit Cost?

Credit is often misused because people do not know what they are paying—especially in consumer credit. Interest is the cost of using someone else's money. The true rate of interest varies a great deal. The actual simple annual interest rate may be something quite different from what you are sometimes told.

Suppose you borrow $1,000 for two years and pay it back at $50 a month for 24 months:

You get			$1,000
You pay back	24 x 50	=	$1,200
Your loan cost			$ 200

Is this $\frac{200 \times 100}{1{,}000}$ = 20 per cent over two years?

= 10 per cent per year?

Or is it something else?

Remember you haven't had the use of $1,000 for the full two years. You have been paying back some each month. What then is the actual interest rate?

Use This Formula and Know for Sure—

$$\text{True Interest Rate} = \frac{(\text{Number of Payments}) \times (\text{Amount paid back} - \text{amount received} \times (100)}{(\text{Number of Years} \times (\text{Number of Payments} + 1)\ (\tfrac{1}{2}\ \text{original loan})}$$

The True Interest Rate in the Above Case is Therefore—

$$\frac{24 \times (24 \times 50 - 1{,}000) \times 100}{2 \times 24 + 1) \times 500} =$$

$$\frac{24 \times 200 \times 100}{2 \times 25 \times 500} = \frac{96}{5} = 19.2 \text{ per cent per year}$$

Where to Borrow?

When you have decided credit is the best solution to your particular problem you need to know the sources of credit. These are outlined in Form 8.

SOURCES OF FARM CREDIT

Source	Money can be used for	Interest Rate	Regulations and Stipulations
(1) **Farm Improvement Loans** Handled by chartered banks under a system of federal government backing.	Purchase of farm implements, breeding stock and in the case of land owners to build or alter farm buildings, fences, electrical heating, plumbing, drainage systems, but not for the purchase of land.	5 per cent	Principle occupation must be farming. The maximum loan available to a farmer at any one time is $15,000. Loans can be made to cover from 60 per cent of the cost of the items in the case of second hand equipment, up to 90 per cent on some of the loans made for real estate, construction or improvement. Length of repayment depends on the size of loan, but in the case of farm implements the maximum length of time is three years. Maximum on some of the other loans is 10 years. Security in most cases is taken on the purchased item only.
(2) **Farm Credit Corporation.** Crown corporation of the Federal Goverment reporting to the Minister of Agriculture. Funds are borrowed from the Federal Government by the corporation and loaned to farmers. Alberta Branch office is located in Edmonton with 31 Field Offices in major centres throughout the province.	To be used primarily to meet long-term credit needs, for reorganization of farms involving the purchase of land, improvements to land and buildings; purchase of basic herd livestock and essential farm equipment; discharge of liabilities or any purpose which the corporation may consider necessary for the assembly and operation of an economic family farm unit.	Amortized payments up to 30 years. Part II loans: 5 per cent on the first $20,000 and 6⅝ per cent on the next $20,000. Part III loans: 5 per cent on the first $27,000 — 6⅝ per cent on the next $27,500 an additional ½ per cent charge on all arrears.	Principle occupation must be farming. The applicant must provide a suitable plan for the assembly of a farm unit capable of producing sufficient income to meet all operating costs, and provide an adequate standard of living and orderly repayment of the required credit. The security taken is a first mortgage on the land owned or to be purchased with loan assistance and operated by the applicant. Part II Loans: are secured on real estate only; the maximum loan is the lesser of $40,000 or 75 percent of the Agricultural Productive Value. Part III Loans: can be made to individual farmers between the ages of 21 and 45 with five years farming experience. This loan can be secured by first mortgage on real estate, livestock, and equipment with the maximum loan being $55,000 or 75 per cent of the acceptable security. Group life insurance is available to all borrowers and is compulsory for all Part III borrowers. The applicant is required to pay an application fee and all legal costs involved in the processing of the loan.
(3) **Veteran's Land Act** Administered and advanced by the V.L.A. Department of the Federal	To purchase land, buildings, permanent, improvements, livestock, farm equipment, discharge liabilities or any other purpose that may be	3½ per cent on the initial Part I loan. 5 per cent on Part III loans to a maximum of $20,000.	Borrower must satisfy minimum service requirements, and pass a screen board as to suitability as a farmer. The maximum loan available under Part I of the act is $6,000. The borrower has to make a down payment of 10 per cent. Repayments can be spread over 30 years with annual, semi-annual or monthly installments available. Associated with the Part I loan is a

Source	Money can be used for	Interest Rate	Regulations and Stipulations
Government to veterans only.	considered necessary for the operation of the farm.	6⅜ per cent on the amount greater than $20,000.	conditional grant of $2,320. In addition to the Part I loan a veteran can apply for a Part III loan. The maximum Part III loan attainable by a commercial farmer is $40,000. In cases where the applicant has a previous Part I and/or Part III loan the total loan attainable is $40,000 less (a) the present outstanding amount of the existing Part I loan plus (b) the outstanding amount of any previous Part III loan. Under no circumstances can the total of Part I and Part III loans to commercial farmers exceed the lessor of $40,000 or 75 per cent of the acceptable security. The maximum Part III loan attainable by an owner of a small family farm is $18,000 less (a) and/or (b) (from above). Under no circumstances can the total of Part I and Part III loans to the small family farm owner exceed the lessor of $18,000 or 75 per cent of the acceptable security. Repayment of Part III loan can be amortized over 30 years, with annual, semi-annual or monthly installments.
(4) **Credit Unions** Set up by interested members and incorporated as a credit union under the Credit Union Act, administered by the Co-operative Activities Branch, Department of Industries and Development, Alberta Government.	Anything the borrower wishes including personal as well as business items.	One per cent per month maximum interest allowed.	The maximum available to a borrower depends strictly on the resources of the credit union and the security offered and ability of the borrower to repay. These stipulations are set up by the Credit Union's own board of directors. Usually the loan can be considered short term to intermediate credit with a maximum borrowable of several thousand dollars over several years, the amount and length of time depending on Credit Union assets and security of borrower. Security taken will depend on the particular Credit Union policy, but may include real estate securities or chattels.

Source	Money can be used for	Interest Rate	Regulations and Stipulations
(5) **Farm Purchase Credit Act**—Loans are processed through a Farm Purchase Board which is set up by municipal by-law and agreement with the Government of Alberta.	For the purchase of land to assist farmers in establishing economic farm units, and at the same time to provide a substantial down payment to the person who is selling the farm.	5 per cent.	The purchase upon approval by the Board, makes a down payment of 20 per cent on the land. The Government pays approximately 80 per cent or a maximum of $24,000. The debt can be paid over a period of up to 20 years, provided payments do not go beyond the borrower's 66th birthday. Loans will be made only on a farm which is self-supporting, or for which an addition is required to make it so. Assistance can be granted only if the proposed purchase and present holdings do not exceed a value of $50,000.
(6) **Ordinary Bank Loans**	Usually for operating capital and other transactions of a short term nature. Banks do not make loans for land purchases in the sense of mortgages, but may make short term loans of less than one and up to several years duration for that or any other purpose.	Presently about 6 per cent on farm loans.	Security may be bonds, other securities, real estate, but not usually chattels. Payments can be arranged to suit the farmer's production cycle but most bank loans to farmers can be considered short term of possibly a year's duration.
(7) **Insurance, Trust and Mortgage Companies**	Usually purchase of real estate.	Usually fairly competitive with banks.	Mortgage, insurance and trust companies have largely withdrawn from loaning money on land after their loss experience during the depression of the thirties. In some cases, they may loan on superior quality land, but this money source can be considered strictly limited to farmers.
(8) **Merchant, dealer, and finance companies**	Supplies, equipment bought both for business and personal.	Usually range from 10 per cent to 25 per cent averaging around 20 per cent.	Credit through these sources is usually easily obtained directly or indirectly through dealers wishing to sell their product, or through loan companies set up strictly to make money loans. In return for the high interest rates, the loan is usually easily obtained, without embarrassment and often with little or no definite tangible security required.

Source	Money can be used for	Interest Rate	Regulations and Stipulations
(9) **Agricultural Processors and Feed Companies**	To be used in one or more of the steps in the production of some farm commodity.	Usually competitive with interest rate.	Usually there is a contract of some type integrating the farmer and processor. Each is required to live up to a certain set of rules established in the contract. The contracted product usually goes to the contracting processor, or in the case of a feed company, the farmer must use its feed.
(10) **Feeder Associations** are set up under the Co-operative Association Act, but operate under the Feeder Associations Guarantee Act which is administered by the Livestock Branch, Alberta Dept. of Agriculture. Money is acquired by the association wherever it can obtain the best interest rate.	The purchase of feeder cattle and lambs.	Presently 5¾ to 6 per cent.	An association can borrow a maximum of $500,000 with upper limits set on the maximum amount which any individual may borrow, usually about $6,500. No breeding stock may be purchased under this loan. The provincial government guarantees loaning institutions against losses up to 25 per cent of the total loans out for that feeder association. Feeder associations operate most successfully in a predominantly livestock feeding district and thus tend to be limited to farming areas where livestock feeding is a major and permanent enterprise.

Other smaller sources of credit under provincial legislation are the Homestead Lease Loans Act allowing up to $1,000 for land clearing, and Rural Electrification Revolving Fund Act.

AGRICULTURAL SERVICES

AGRICULTURAL SERVICES
ALBERTA DEPARTMENT OF AGRICULTURE

Administration — Seven divisions make up the Alberta Department of Agriculture and division directors report directly to the deputy-minister of agriculture. The deputy-minister is responsible for general direction, administration of policy, personnel and accounting.

Animal Industry Division — The Animal Industry Division is composed of the Livestock, Poultry and Dairy Branches. It administers the cattle improvement policies, regulates artificial insemination, beef cattle performance testing, dairy heifer calf policy, feeder associations, sheep and swine improvement policies, licenses stockyards and livestock dealers, records brands and inspects them and administers the horned cattle purchases act.

Services of the dairy branch include inspection of dairy manufacturing plants, licensing frozen food lockers and doing extension work among dairy producers. The branch also carries out regulatory work regarding dairy products. The poultry branch gives information on feeding and management to flock owners, publishes statistics and situation reports and performs blood tests for pullorum-typhoid diseases and other tests to flocks producing hatching eggs.

Economics Branch — The Economics Division consists of six branches. They are — farm management, marketing, statistics, production economics research, rural development research and the farm purchase credit board. The economics division carries out farm management extension, makes surveys on the costs and returns of producing agricultural products and conducts surveys on the social-economic condition of underdeveloped regions. In addition, it collects agricultural statistics, carries out extension programs on buying and selling and informs farmers, farm organizations and government departments on the economic aspects of government programs. The branch also administers the Farm Purchase Credit Act and the Farm Home Improvements Act.

DISTRICT AGRICULTURISTS

OFFICE	ADDRESS
ATHABASCA	Box 480
BARRHEAD	Box 850
BERWYN	Box 36
BONNYVILLE	Box 160
BROOKS	Box 788
CALGARY	702-16 Ave. N.W.
CAMROSE	Prov. Bldg.
CARDSTON	Box 38
CLARESHOLM	Box 40
CORONATION	Box 160
DRUMHELLER	Box 578
EDMONTON SOUTH	10426-81 Ave.
M.D. of Strathcona	(County Office)
EVANSBURG	
FAIRVIEW	Box 819
FORT VERMILION	Box 40
GRANDE PRAIRIE	Prov.Bldg.
HANNA	Box 349
HIGH PRAIRIE	Box 568
HIGH RIVER	Box 490
LAC LA BICHE	Box 389
LACOMBE	Box 99
LAMONT	Box 359
LEDUC	Box 248
LETHBRIDGE	Admin. Bldg.
MEDICINE HAT	826-2 St. S.E.
MORINVILLE	County Building
OLDS	Box 250
PONOKA	Box 70
RED DEER	Prov. Bldg.
ROCKY MTN HSE.	Box 700
RYLEY	Box 200
SANGUDO	
SEDGEWICK	Box 9
SMOKY LAKE	Box 70
SPIRIT RIVER	Box 189
STETTLER	Box 1119
STONY PLAIN	Box 510
STRATHMORE	Box 125
ST. PAUL	Box 188
TABER	Box 640
THORHILD	Box 370
TWO HILLS	Box 487
VEGREVILLE	Box 519
VERMILION	Box 600
VULCAN	Box 480
WAINWRIGHT	Box 459
WESTLOCK	Box 429
WETASKIWIN	Box 130
FOREMOST	Box 326
THREE HILLS	Box 790

Extension and Colleges Division —
This division has six main branches or sections, including agricultural and vocational colleges, district agriculturists, district home economists, extension agricultural engineers, radio and information, and publications and visual aids.

The three agricultural and vocational colleges prepare young men and women for farming, homemaking and for positions in the agricultural and business world. The Extension Branch provides the link between agricultural research and profitable farm practices. Agricultural and homemaking information and a consulting service on agriculture and homemaking is available to all farm families wanting to use the service.

Plant Industry Division — The Plant Industry Division includes apiculture, crop improvement, crop clinic, crop protection and pest control, horticulture, weed control, soils, special crops and special projects.

The plant industry division is in charge of stamping out bee diseases, improving crops and cropping practices, dealing with crop pests and diseases, growing and testing horticultural crops at Brooks, Alta., and distributing trees for field and farmstead shelterbelts. Weed control and information on soil conservation and fertility along with grants made to seed processing plants set up by farmer's associations are made by this branch.

Program Development Division — This division's programs includes ARDA, lands and forests utilization and agricultural products marketing council. It is the trustee of Lethbridge Northern Irrigation and United Irrigation districts. In addition, it is in charge of the development of new agricultural department programs and departmental liason for applied research and water resources.

Veterinary Services Division — The veterinary division includes the Fur Farms Branch and the Emergency Measures Organization. The division is concerned with the prevention, control and diagnosis of livestock diseases as well as veterinary extension work. Brucellosis Restricted Areas veterinary inspection at stockyards are large activities. Some investigation and experimental work is done.

Water Resources Division — The Water Resources Division includes activities of the previous Colonization Branch. The water division measures, surveys and assess all water sources in Alberta. It licenses all works which diverts water for any purpose, investigates all drainage proposals, forms and plans water development in the drought areas of the province and supervises all irrigation engineering development authorized by the Alberta government. Engineers of the Water Resources Division construct drainage, irrigation, water supply, river control and erosion works when it is in the public interest. The division also deals with problems concerning rivers which flow into other provinces and the United States.

CANADA DEPARTMENT OF AGRICULTURE

The Canada Department of Agriculture helps farmers in three broad ways. These are through research, promotional and regulatory services and assistance programs. The department has three main branches — Research, Health of Animals and Production and Marketing. Other special services include the Prairie Farm Rehabilitation Act, the Prairie Farm Assistance Act, the Agricultural Products Board and the Crop Insurance Board.

Research — Alberta has one federal research station at Lethbridge, four experimental farms and three sub-stations operated by the federal agriculture department. This research is co-ordinated with the efforts of the University of Alberta's agricultural college. A soil survey unit is carried on in co-operation with the provincial government.

Health Of Animals — This branch looks after the detection and control of contagious animal diseases. In addition, it inspects meat processed in Alberta and makes sure animals are slaughtered in a humane manner.

Production and Marketing Branch — Regulatory and promotional activities are carried on by the Production and Marketing Branch. This involves grading and inspecting agricultural products, plant disease control and regulation of trade in seeds, feeds and fertilizers and performance testing of livestock and poultry.

There are six divisions and three sections in the Production and Marketing Branch.

Livestock Division — The Livestock Division grades meat, wool and fur. It registers livestock pedigrees, performance tests cattle and hogs, promotes livestock improvement and compiles market statistics.

Poultry Division — The Poultry Division performance tests poultry, inspects hatcheries and administers regulations for the grading of poultry products.

Fruit and Vegetable Division — This division grades fruits and vegetables in fresh and processed form and licenses fruit and vegetable brokers.

Dairy Division — The Dairy Division administers the grading of dairy products.

Plant Products Division — This division administers the grading of seeds and feedstuffs and administers policies dealing with fertilizers and pest control.

Plant Protection Division — This division safeguards against the introduction of dangerous plant insects and diseases into Canada and protects against the spread of such insects and diseases.

Markets Information Section — The markets section compiles and distributes market information about livestock, meats, wool, dairy products, eggs, poultry, fruit and vegetables.

Consumer Section — This section helps promote the proper use of Canadian food products.

General Services and Cold Storage Section — This section administers the subsidization of public cold storage facilities.

In addition, the Canadian Department of Agriculture has special programs and agencies to meet special problems of the regions. The Prairie Farm Rehabilitation Act deals with the problems posed by the drouth of the 1930's. It works to develop pasture and water resources. The Prairie Farm Assistance Act deals with the results of crop failure. The Farm Credit Corporation provides long-term mortgage loans for farmers.

The Board of Grain Commissioners under the authority of the Canada Grain Act controls and supervises grain handling in Canada. The Canadian Wheat Board sells all wheat, oats and barley produced in western Canada and sold to other provinces or foreign countries.

RESEARCH BRANCH

Beaverlodge Experimental Farm —
Field and horticultural crops, livestock, apiculture and soils.

Edmonton — Alberta Soil Survey, University of Alberta. Pedology and Soil Survey.

Fort Vermilion Experimental Farm — Field crops.

Lacombe Experimental Farm — Animal and poultry breeding, plant breeding, crop management and soils, plant nutrition and agricultural engineering.

Lethbridge Research Station — Irrigated and dryland agriculture involving livestock, field and horticultural crops, livestock nutrition, wool research, insects and diseases affecting field and horticultural crops and insects affecting livestock and their control.

Manyberries Experimental Farm — Animal husbandry and range management.

Stavely — Range substation.

Vauxhall — Soils drainage substation.

Vegreville — Solonetzic soil substation.

PRODUCTION AND MARKETING BRANCH

Brooks —

Fruit and Vegetable Division Office	Post Office Building.

Calgary —

Dairy Products Division	530 Public Building.
Fruit and Vegetable Division	502 Public Building.
Livestock Division	C/O Alberta Stockyards.
Plant Products Division	Immigration Building.
Analytical Control Laboratory	102 - 11th Ave. E.
Poultry Division	514 Public Building.
General Service Section	533 Public Building.

Edmonton —	
Dairy Products Division District Office	822 Federal Building.
Fruit and Vegetable Division	821 Federal Building.
Livestock Division District Supervisor	831 Federal Building.
Plant Products Division District Supervisor	870 Federal Building.
Plant Protection Division Office	820 Federal Building.
Inspection and Seed Potato Certification	820 Federal Building.
Poultry Division Office	899 Federal Building.
General Service Section	878 Federal Public Building.
Grande Prairie —	
Plant Products Division	P.O. Box 3117.
Lethbridge —	
Fruit and Vegetable Division	306 Public Building.
Livestock Division	Post Office Building.
Plant Products Division	Post Office Building.
Plant Protection Division	310 Post Office Building.
Poultry Division	315 Federal Building.
Red Deer —	
Livestock Division	103 Public Building.
Plant Products Division	212 Public Building.
Poultry Division	214 Public Building.

HEALTH OF ANIMALS BRANCH

Athabasca	Federal Building.
Brooks	
Calgary	403 Public Building.
Coutts	P.O. Box 143.
Drumheller	Post Office Building.
Edmonton	761 Federal Building.
Fort Macleod	2305 Second Ave.
Grande Prairie	9924 Richmond Ave.
Lethbridge	401 Post Office Building.
Medicine Hat	Federal Building.
Olds	Popowich Building.
Peace River	Post Office Building.
Red Deer	108 Federal Building.
Stettler	Post Office Building.
Vermilion	Federal Building.
Wetaskiwin	Federal Building.

SPECIAL ACT ADMINISTRATION

Prairie Farm Assistance Administration — PFAA —	Federal Building, Edmonton.
Prairie Farm Rehabilitation Administration — PFRA —	Public Building, Calgary. Federal Building, Lethbridge.
District Offices	Federal Building, Vauxhall.
Regional Offices.	Hanna, Medicine Hat, Fort Macleod, Peace River, Red Deer, Vegreville, Westlock.

Registration of Purebred Animals:

Correspondence concerning the registration of purebred animals of all breeds except Holstein-Friesian cattle, should be sent to the Accountant, Canadian National Livestock Records, Department of Agriculture, Ottawa. For the registration of Holstein-Friesian cattle, write the secretary, Holstein-Friesian Association, Brantford, Ontario.

FARM CREDIT CORPORATION

Regional Office — 100 Street and 101A Avenue, Edmonton

BOARD OF GRAIN COMMISSIONERS

Inspection — 619 Public Building, Calgary
Canadian Government Elevator, Lethbridge
814 McLeod Building, Edmonton

Canadian Government Elevators — 627 Federal Building, Calgary
Canadian Government Elevator, Edmonton
Canadian Government Elevator, Lethbridge

CANADA WHEAT BOARD

Branch Office for Alberta, 201 Executive Building, 509 Third Street, S.W., Calgary

UNIVERSITY OF ALBERTA

Department of Agricultural Economics — The Department of Agricultural Economics is involved in teaching, research and continuing education on the economics of agricultural adjustment, finance, management, marketing, policy, prices, production and rural development.

Department of Agricultural Engineering — The Department of Agricultural Engineering, besides teaching students, provides information on farm power and machinery, farm buildings and services, handling and storing agricultural materials.

Department of Animal Science — The Animal Science Department teaches does research and extension in animal science with specialization in nutrition, breeding, management and production. Animal science includes both poultry and livestock.

Department of Dairy and Food Science — Information on production, handling and processing of milk is provided by the dairy and food science department. It also works on problems of milk processing, principles of food processing and problems concerning agricultural microbiology.

Department of Entomology — This department provides information on the identification and control of insects.

Department of Genetics — The genetics department provides information on cereal and forage varieties.

Department of Plant Science — The department teaches, does research and extension on horticulture, plant pathology, plant physiology and biochemistry and weed science. It is involved in both basic and applied agricultural research.

Department of Soil Science — The soil science department provides information on soil fertility, use of commercial fertilizers, barnyard manure, straw and stubble. It also provides information on the use of mineral soil amendments such as gypsum and lime, crop rotations, improvement and fertilization of soils for lawns and gardens. Other subjects dealt with by soil science are: soil erosion, irrigation, soil salinity and soil ratings and soil survey reports and innoculation of legumes.

Agricultural Soil and Feed Testing Laboratory — This laboratory, on the Edmonton campus, tests soil and feed for Alberta farmers, home owners and greenhouse operators. Only samples of unmixed farm-grown feeds are accepted for analyses. Recommendations based on the analyses made are sent to those submitting samples.

Instructions and sample containers are available from the laboratory or from district agriculturists. This service will be located in the Alberta Department of Agriculture Consolidated Laboratory when that building is opened about 1968 or 1969.

Extension Department — The University of Alberta's Extension Department distributes a variety of agricultural publications prepared by university staff members. It keeps its pamphlet service up-to-date with current listings of pamphlets, bulletins and publications from other major Canadian and United States sources. There is an advisory service on community leadership with related residential training programs. Speakers are provided upon request.

The extension department is a consultant in community development, provides a wide variety of courses in liberal studies, business and technical subjects, public affairs, local government, human relations, and fine arts. It also has a selection of directed reading and study discussion programs for home use. The extension department has a film library covering agricultural and other subjects. Finally, there is the extension library service with 60,000 volumes available through openshelf borrowing and travelling.

APPENDIX A

A. WEIGHTS AND MEASURES USED IN AGRICULTURE

Canadian Government Land Measures

— A township — 36 sections, each a mile square.
— A section — 640 acres.
— A quarter section — half a mile square, 160 acres.
— An eighth section — half a mile long, north and south, and a quarter of a mile wide — 80 acres.
— A sixteenth section — a quarter of a mile square — 40 acres.

The sections are all numbered 1 to 36, commencing at the southeast corner of the township.

The sections are divided into quarters, which are named by the cardinal points. The quarters are divided in the same way. The description of a certain forty-acre lot would read: The south half of the west half of the southwest quarter of section 1 in township 24, range 7, west of the fourth meridian. A description sometimes will fall short and sometimes overrun the number of acres it is supposed to contain.

Land Measure

To find the number of acres in a body of land, multiply the length by the width (in rods), and divide the product by 160. When the opposite sides are unequal, add them and take half the sum for the mean length or width. An acre contains 4,840 square yards, or 43,560 square feet. A square acre measures 208.71 feet on each side.

COMMON MEASURES

Long Measure:

12 inches	1 foot
3 feet	1 yard
5½ yards	1 rod
320 rods	1 mile
1 mile	1,760 yards
1 mile	5,280 feet

The following are also used:

1 size	⅓ inch (used by shoemaker)
1 hand	4 inches (used in measuring the height of horses)
1 fathom	6 feet (used in measuring depths at sea)

Surveyor's Linear Measure:

7.92 inches	1 link
100 links	1 chain
80 chains	1 mile

(Gunthers chain is the unit and is 66 feet long)

Liquid Measure:

4 gills	1 pint
2 pints	1 quart
4 quarts	1 gallon

1 gallon contains 277.42 cubic inches.
1 cubic foot equals 6.25 gallons.

Square Measure:

144 sq. ins.	1 sq. ft.
9 sq. ft.	1 sq. yd.
30¼ sq. yds.	1 sq. rd.
160 sq. rods	1 acre
4,840 sq. yds.	1 acre
43,560 sq. ft.	1 acre
640 acres	1 sq. M.

An acre is equal to a square whose side is 208.71 feet.

Surveyor's Square Measure:

10,000 square links	1 sq. chain
10 square chains	1 acre

Dry Measure:

2 pints	1 quart
8 quarts	1 peck
4 pecks	1 bushel

1 Imperial bushel contains 2,219.36 cubic inches or approximately 1.28 cubic feet.

Cubic Measure:

1,728 cubic inches	1 cubic foot
27 cubic feet	1 cubic yard
128 cubic feet	1 cord

Commodity Weights and Measures:

A pint's a pound and a quarter of the following: water, wheat, butter, sugar, blackberries.

An Imperial gallon of milk weighs 10.32 pounds; cream, 10 pounds; 38.7 quarts of milk weigh 100 pounds.

A keg of nails weighs 100 pounds. A barrel of flour weighs 196 pounds, of salt, 280 pounds; of beef, fish, or pork, 200 pounds; cement (4 bags) 376 pounds.

An Imperial bushel contains 2,219.36 cubic inches.

A board foot = 144 square inches; a cord contains 128 cubic feet.

Lumber Measure:

To find the area of boards, in square feet —

Rule:— Multiply the length (in feet) by the width (in inches) and divide the product by 12.

Example: Find the area of a 16 foot board, 9 inches wide —
9 x 16 = 144 ÷ 12 = 12 square feet.

To find the board foot measure of boards, scantlings, joists, etc. —

Rule:— Multiply the length, thickness, and width together, and divide the product by 12.

Example: Find the contents of an 18-foot joist, 2 x 8 —
2 x 8 x 18 = 288 ÷ 12 = 24 board feet.

To Measure Cordwood:

To find the contents of a pile of cordwood, multiply the length, width, and height together and divide the product by 128. This will give you the number of cords.

To Find Number of Board Feet in a Log:

Subtract 4 inches from the diameter and square the remainder. The result will be the number of board feet in a 16 foot log. Add ⅛ for 18 foot logs, ¼ for 20 foot logs. Subtract ⅛ for 14 foot logs, ¼ for 12 foot logs.

Measuring Water:

One inch of rainfall means 100 tons of water on every acre.

An Imperial gallon of water equals 277.42 cubic inches and weighs 10 pounds.

A cubic foot of water equals 6¼ Imperial gallons and weighs 62½ pounds.

Water expands 1/11 of its bulk in freezing.

Doubling the diameter of a pipe or cylindrical vessel increases its capacity four times.

Cistern Capacity:

A cistern five feet in diameter will hold five and two-thirds barrels for every foot in depth.

A cistern eight feet in diameter will hold nearly twelve barrels for every foot in depth.

A cistern ten feet in diameter will hold eighteen and three-eighths barrels for every foot in depth.

To find the capacity of cylindrical tanks, square the diameter in inches, multiply by the height in inches, and this product by 28.33. Point off four decimals and you have the capacity in Imperial gallons.

To Find the Contents of Square Tanks:

Rule:— Multiply the area of the bottom by the height in order to secure the cubic feet. Multiply the cubic feet by 6.25 and the result will be the number of Imperial gallons.

For the contents in barrels, multiply the cubic feet by .2375.

To Find the Contents of Barrels and Casks in Imperial Gallons:

Rule:— Multiply the square of the mean diameter (in inches) by the depth (in inches) and the product by .002833.

B. CAPACITIES & MISCELLANEOUS DATA (BUILDINGS)

Approximate Hay Capacity for Semicircular Cross-Section Buildings, Tons Per Foot of Length:

	Building Width	
	32 Ft.	40 Ft.
Long Hay	⅔	1
Chopped Hay	1	1½
Field-baled (twine)	1⅓	2
Field-baled (wire, medium-tight)	2	3
Loose Straw	⅔	1
Chopped Straw	⅞	1⅓

Approximate Hay Capacity for Straight Sidewall Storages, Tons Per Foot of Length:

	Width 32 ft., Height 10 ft.	Width 36 ft., Height 12 ft.	Width 40 ft., Height 14 ft.
Long Hay	0.8	1.1	1.4
Chopped :			
Long	1.0	1.3	1.6
Short	1.5	2.0	2.5
Field-baled :			
Twine	1.6	2.2	2.8
Wire	2.3	3.2	4.2

Approximate Storage-Space Requirements for Feed, Bedding and Materials:

Material	lb./cu. ft.	cu. ft./ton
Loose Hay :		
In shallow mows	3½ - 4	600 - 500
In deep mows	4½ - 5	450 - 400
Baled Hay :		
Field-baled	8 - 14	200 - 250
Ordinary bales	10 - 15	200 - 135
Tight bales	12 - 20	100 - 175
Chopped hay :		
Long (2½ ins. or more)	5½ - 8	360 - 250
Short (less than 2½ ins.)	8 - 10	250 - 200
Loose Straw	3⅔ - 4	600 - 500
Baled Straw :		
Field bales	6⅔ - 8	300 - 250
Tight bales	10 - 13⅓	200 - 150
Chopped Straw	6 - 8	350 - 250
Small Grain	50 - 36	55 - 40
Oats	25 - 35	80 - 55
Mixed Feed concentrates	45	44
Wood Shavings, baled	20	100
Lime	65	31
Ground Phosphate	75	27

MISCELLANEOUS DATA ON FARM ANIMALS

	Dog	Cow	Sheep	Horse	Pig
Normal temperature	100.8	101.4	103.4	100.4	102.2
Pulse rate	90-100	45-50	70-80	36-40	70-80
Respiration	15 - 20	12-30	12-20	8 - 16	10-15
Estral cycle	6 months	21 days	17 days	22 days	21 days
Duration of estrum	1 week	17 hrs.	2 days	6-7 days	3 days
Time of ovulation	1st or 2nd day of estrum	1st day after estrum	1st or 2nd day after estrum	End of estrum	2nd day of estrum
Period of gestation	62 days	282 days	150 days	340 days	115 days

Incubation Periods:

Hen	21 days	Peafowl	28
Duck	28	Pigeon	16 - 20
Duck (Muscovy)	35 - 37		
Goose	30 - 34		
Turkey	28		
Guinea	26 - 28		
Pheasant	22 - 24		

NUMBER OF POUNDS TO THE BUSHEL*

Alfalfa Seed	60	Crseted Wheat Grass	22
Apples (Green)	48	Fescue, Meadow	22
Apples (Dried)	24	Fescue (Other Varieties)	14
Barley	48	Flax Seed	56
Beans (White)	60	Oats	34
Beans (Castor)	46	Onions	57
Beans (Soy)	60	Orchard Grass Seed	14
Bluegrass Seed	14	Peas (Dried)	60
Bran	20	Potatoes	60
Brome Grass	14	Potatoes (Sweet)	50
Buckwheat	48	Red Top Seed	14
Clover (Burr)	10	Rye	56
Clover Seed	60	Timothy Seed	45
Corn (Shelled)	56	Tomatoes	50
Corn (in ear)	70	Turnips	55
Coal, Hard	80	Wheat	60
Coke	40		

*Approximate — Legal Weights may vary.

Measuring Circles:

1. To find the diameter of a circle, multiply the circumference by .31831.
2. To find the circumference of a circle, multiply the diameter by 3.1416.
3. To find the area of a circle, multiply the square of the diameter by .7854.

Calculation of Machine:

Rate of Coverage:—

$$\text{Acres per hour} = \frac{\text{Speed in m.p.h. x width in inches}}{100}$$

APPROXIMATE AMOUNTS ACCORDING TO FENCE LENGTH

2 strand, 12½ gauge hog wire with 2 point, 14 gauge barbs, 3 inches between barbs.

	1 Line	2 Lines	3 Lines
1 rod in length	1 lb.	2 lbs.	3 lbs.
100 rods	100 lbs.	200 lbs.	300 lbs.
100 feet	6-1/16 lbs.	12½ lbs.	18-3/16 lbs.
1 square acre	50⅔ lbs.	101½ lbs.	152 lbs.
1 square mile	1,280 lbs.	2,564 lbs.	3,840 lbs.
1 side of square mile	320 lbs.	640 lbs.	960 lbs.

METRIC WEIGHTS AND MEASURES

Measures of Weights:

10 milligrams (mg.)	=	1 centigram (cg.)
10 centigrams	=	1 decigram (dg.)
10 decigrams	=	1 gramme (grm.)
10 grammes	=	1 dekagram (dag.)
10 dekagrams	=	1 hectogram (hg.)
10 hectograms	=	1 kilogram (kg.)
10 kilograms	=	1 myriagram
10 myriagrams	=	1 quintal (q.)
10 quintals	=	1 millier (commonly known as the "Tonne")

Measures of Length:

10 millimetres (mm.)	=	1 centimetre (cm.)
10 centimetres	=	1 decimetre (dm.)
10 decimetres	=	1 metre (m.)
10 metres	=	1 dekametre (dam.)
10 dekametres	=	1 hectometre (hm.)
10 hectometres	=	1 kilometre (km.)
10 kilometres	=	1 myriametre

Measures of Volume:

10 millilitres (mil.)	=	1 centilitre (cl.)
10 centilitres	=	1 decilitre (dl.)
10 decilitres	=	1 litre (lit.)
10 litres	=	1 dekalitre (dal.)
10 dekalitres	=	1 hectolitre (hl.)
10 hectolitres	=	1 kilolitre

EQUIVALENT VALUES OF STANDARD AND METRIC UNITS

Measures of Weight (Mass):

1 lb. (7,000 grains)	=	453.59 grams
1 ounce	=	28.3495 grams
1 grain	=	0.0648 grams
1 kilogram	=	2.2046 lbs.
1 gram	=	15.432 grains
1 decigram	=	1.54323 grains
1 centigram	=	0.15432 grains
1 milligram	=	0.01543 grains

Measures of Length:

1 inch	=	2.54 centimetres
1 foot	=	30.48 centimetres
1 yard	=	91.44 centimetres
1 mile	=	1.609 kilometres
1 centimetre	=	0.3937 inches
1 metre	=	39.37 inches
1 metre	=	1.0936 yards
1 kilometre	=	0.62137 miles
1 kilometre	=	1000 metres

Measures of Surface:

1 sq. inch	=	6.4514 square centimetres
1 sq. foot	=	929.01 square centimetres
1 sq. yard	=	8361.3 square centimetres
1 sq. yard	=	0.83613 square metres
1 sq. centimetre	=	0.1550 square inches
1 sq. metre	=	10.764 square feet
1 sq. metre	=	1.196 square yards
1 hectare	=	2.471 acres

Measures of Volume:

1 cu. inch	=	16.387 cubic centimetres
1 cu. foot	=	28317 cubic centimetres
1 cu. yard	=	0.7645 cubic metres
1 cu. centimetre	=	0.061 cubic inches
1 litre	=	1000 cubic centimetres
1 litre	=	61.0234 cubic inches
1 litre	=	1.7598 Imperial pints
1 cu. metre	=	1.30794 cubic yards
1 Imperial gallon	=	10 lbs. water at 62° F.
1 Imperial gallon	=	277.42 cubic inches
1 Imperial gallon	=	4.546 litres
1 Imperial quart	=	1.136 litres

Branch Circuit and Feeder Wire Sizes for Various Lengths of Run:

On short runs, where voltage drop does not affect wire size, the table shows minimum permissible commercial size Brown & Sharpe gauge rubber-covered copper wire according to the National Electrical Code.

Based on: Two per cent loss in Voltage on 115-volt, 2-wire circuits.
One per cent loss in Voltage on 220-volt, 2-wire circuits.
One per cent loss in Voltage on 115/230-volt, 3-wire circuits.

Wattage Load 115-Volt Circuit	Amp. Load	Length of Run in Feet																	
		30	40	50	60	70	80	90	100	120	140	160	180	200	240	280	320	360	400
575	5	14	14	14	14	14	14	12	12	12	10	10	10	10	8	8	8	6	6
690	6	14	14	14	14	14	12	12	12	10	10	10	8	8	8	8	6	6	6
805	7	14	14	14	14	12	12	12	10	10	10	8	8	8	6	6	6	6	4
920	8	14	14	14	12	12	12	10	10	10	8	8	8	8	6	6	6	4	4
1,035	9	14	14	12	12	12	10	10	10	8	8	8	8	6	6	6	4	4	4
1,150	10	14	14	12	12	10	10	10	10	8	8	8	6	6	6	4	4	4	4
1,380	12	14	12	12	10	10	10	8	8	8	8	6	6	6	4	4	4	4	2
1,610	14	14	12	10	10	10	8	8	8	6	6	6	6	4	4	4	2	2	2
1,840	16	12	12	10	10	8	8	8	8	6	6	6	4	4	4	2	2	2	2
2,070	18	12	10	10	8	8	8	8	6	6	6	4	4	4	4	2	2	2	1
2,300	20	12	10	10	8	8	8	6	6	6	4	4	4	4	2	2	2	1	1
2,875	25	10	10	8	8	6	6	6	6	4	4	4	2	2	2	1	1	0	0
3,450	30	8	8	8	6	6	6	6	4	4	4	2	2	2	1	1	0	0	2/0
4,025	35	8	8	6	6	6	4	4	4	4	2	2	2	1	1	0	2/0	2/0	3/0
4,600	40	6	6	6	6	4	4	4	4	2	2	2	1	1	0	2/0	2/0	3/0	3/0
5,175	45	6	6	6	6	4	4	4	2	2	2	1	1	0	2/0	2/0	3/0	3/0	4/0
5,750	50	6	6	6	4	4	4	2	2	2	1	1	0	0	2/0	3/0	3/0	4/0	4/0
6,900	60	4	4	4	4	4	2	2	2	1	1	0	0	2/0	3/0	3/0	4/0	4/0	
8,050	70	4	4	4	4	2	2	2	1	1	0	2/0	2/0	3/0	3/0	4/0	4/0		
9,200	80	2	2	2	2	2	2	1	1	0	2/0	2/0	3/0	3/0	4/0	4/0			
10,350	90	2	2	2	2	2	1	1	0	2/0	2/0	3/0	3/0	4/0	4/0				
11,500	100	1	1	1	1	1	1	0	0	2/0	3/0	3/0	4/0	4/0					
13,800	120	0	0	0	0	0	0	0	2/0	2/0	3/0	4/0	4/0						

Note: For good voltage regulation design feeders for a maximum of one per cent voltage drop, branch circuits for a maximum of two per cent voltage drop.

Where wire larger than 10 is required to eliminate excessive voltage drop on branch circuits, split the circuits, or move the panel board closer to the load centre.

Length of Run is the one-way distance from source of supply to panel or from panel to outlet. The length of wire required between these points is double this distance for 2-wire circuits and three times this distance for 3-wire circuits.

Westinghouse Lighting Handbook, Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey, U.S.A.

4-INCH AUGER CONVEYORS — GRAIN**

Speed rpm	Angle	Approx. HP per 10 ft.	Maximum capacity, bu./hr. Wheat	Oats	Cornmeal
	Horiz.	0.22	220	200	220
300 —	45°	0.26	140	140	190
	Vert.	0.21	60	40	40
	Horiz.	0.28	290	260	290
400 —	45°	0.34	190	170	270
	Vert.	0.28	80	60	170
	Horiz.	0.35	420	340	500
600 —	45°	0.47	250	220	390
	Vert.	0.41	140	90	240

6-INCH AUGER CONVEYORS — GRAIN**

Speed rpm	Angle	Approx. HP per 10 ft.	Maximum capacity, bu./hr. Wheat	Oats	Cornmeal
	Horiz.	0.48	810	770	910
300 —	45°	0.60	490	470	600
	Vert.	0.45	230	230	500*
	Horiz.	0.55	1000	900	1030
400 —	45°	0.80	580	530	670*
	Vert.	0.64	330	270	560*
	Horiz.	0.82	1180	1050	1270
600 —	45°	1.00	690	600	820
	Vert.	0.90	450	340	650*

* Tested at 60°; cornmeal bridged at intake at angles greater than 60°.

** Power requirements and capacities are generally accurate when auger is operating full.

CALCIUM CHLORIDE FOR RUBBER TIRES

Tire Size	Water only: Imp. Gals.	Lbs.	Slush Free, + 13° F.; Solid, –23° F.: Imp. Gals. Water	Pounds CaCl2	Pounds Weight in Tire	Slush Free, –12° F.; Solid, –52° F.: Imp. Gals. Water	Pounds CaCl2	Pounds Weight in Tire
6.00 x 16	5.0	49	4.6	11	56	4.4	18½	60
6.50 x 16	5.6	57	5.2	12½	65	5.0	21	69
7.50 x 15	6.7	67	6.0	14½	75	5.8	24½	83
7.50 x 16	7.5	75	6.8	16½	85	6.5	27	91
11.2-34/10-34	24.0	246	22.5	54	279	20.8	89	300
11.2-38/10-38	26.7	270	25.0	59	306	23.3	97	329
12.4-26/11-26	25.8	262	23.3	57	297	22.5	94	319
12.4-28/11-28	27.5	276	25.0	61	314	23.3	99	338
12.4-36/11-36	33.3	336	30.8	74	380	29.2	120	410
12.4-38/11-38	35.0	351	31.7	77	398	30.0	126	427
13.6-26/12-26	31.6	322	29.2	63	365	27.5	116	394
13.6-28/12-28	34.0	340	30.8	67	386	29.2	122	414
13.6-38/12-38	42.5	427	39.2	85	480	36.7	155	520
14.9-24	37.5	375	35.0	83	428	32.5	136	462
14.9-26/13-26	40.0	400	36.7	88	454	34.2	144	485
14.9-28/13-28	41.7	422	38.3	92	477	35.9	152	513
14.9-38/13-38	53.3	530	48.3	117	602	45.8	191	645
15.5-38	55.8	558	48.3	128	611	47.1	175	646
16.9-24/14-24	45.8	500	41.7	99	522	39.2	167	555
16.9-26/14-26	48.3	586	44.2	106	552	41.7	175	590
16.9-30/14-30	54.0	538	49.2	118	612	45.8	193	656
16.9-34/14-34	60.0	592	54.2	131	672	50.8	213	722
18.4-30/15-30	70.0	705	64.2	154	800	60.0	253	859
18.4-34/15-34	76.7	769	70.0	169	874	65.8	377	936
23.1-26/18-26	105.8	1060	97.5	233	1205	90.8	382	1290

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